The Journal
OF THE
Royal United Service Institution.

VOL. XXII. 1878. No. XCIV.

THE NAVAL PRIZE ESSAY, 1878.

GREAT BRITAIN'S MARITIME POWER: HOW BEST DEVELOPED AS REGARDS:—

1. FIGHTING SHIPS.
2. PROTECTION OF COMMERCE.
3. NAVAL, VOLUNTEER, OR SUPPLEMENTAL FORCE.
4. COLONIAL AND HOME DEFENCE; THE CLASSES, ARMAMENT, AND DESCRIPTION OF THE VESSELS NEEDED; AND THE ORGANIZATION REQUIRED TO SECURE A POWERFUL AND ECONOMIC IMPERIAL NAVAL FORCE.

By Captain PHILIP H. COLOMB, R.N.

"Esto quod esse videris."

1. It would be difficult to suggest a naval subject capable of more comprehensive and exhaustive treatment than this, which the Council of the Royal United Service Institution have announced for the year 1877; and it may be a matter of regret to many an essayist, that he must compress into 48 pages his possibly overflowing thoughts on the grand theorem.

2. But I conceive that, willingly or unwillingly, any essayist who attempts to deal with the matter presented to him, must do so on the prescribed lines. He must be as full as the limited space at his disposal will admit; he must be as complete as his knowledge allows; and he must deal with his subject according to the classification of its component parts which is furnished for his guidance. I shall therefore endeavour to let these rules govern the observations contained in the following pages.

3. It is, perhaps, so far fortunate that these limits of classification have been drawn; for were "the development of the maritime power "of Great Britain" left without note or comment, as the subject of the

essay, the views of the competitors might turn out so various and so contradictory, that an undue pressure would be placed on the shoulders of the judges, even if any really useful result were achieved. But on the other hand, an essay would never be complete which failed at the outset to grasp its subject as a whole, and to announce with what central figure the subordinate groups were to combine, in order that the picture might harm the eye with its beauty, and the sense with its truth.

4. My conviction is, that in considering our naval power and its development as a whole, we too commonly fall into the error which is sometimes apparent in our military designs. We are too apt in both cases to overlook the differences which exist in the circumstances of nations, and to regard our own empire as liable to the same dangers and amenable to the same military or naval treatment as all others. We thus commit a double mistake; we suppose that all other nationalities present similar naval and military features—which they do not—and we fancy that we ourselves exhibit a correspondence in circumstances, temper, and character, with that which we have imagined to be common to all our neighbours. Amongst the nations we are like one of our countrymen who happens to own a foreign ancestry, and to carry a foreign air unconsciously. Such a man will often aim at the uniformity which he thinks he perceives around him, unaware of the peculiarities which others see in him, and which being fundamentally natural, can never be shaken off. If we look for it we can readily detect, in the spoken and written words of our foreign naval critics, their opinion of the singularity of Great Britain's naval position; and sometimes perhaps we may trace a certain covert surprise on their part, whenever our naval policy appears to *follow* that of any other country.

5. History and tradition—our excellent friends if treated with intelligent confidence, but our mortal enemies if allowed an unrecognized sway—are in some degree to blame for this national failing. Many of our famous naval wars have been carried on with nations whose circumstances were not very dissimilar to our own. When the Hollanders fought with us, we both strove for the same prize, the acknowledged dominion of the Narrow Seas. The south and east coasts of England were matched against the shores of Holland. The conditions were alike; the field of battle was localized, and close at hand; so that if the Citizen Navy in its latter days imitated the dash of Prince Rupert, and carried the war into our rivers, the Royal Navy of the second Charles was glad to borrow the fighting formation of the enemy's fleet. Both nations, in short, fought on an equal footing, were liable to the same dangers, and experienced the same chances of success at sea. It was in the nature of things that their Naval views should agree, and should produce identical results in policy. In the French wars prior to those of the Revolution and the Empire, the Naval circumstances of France and of England did not so greatly differ. Each had a seaboard trade—vast for that epoch—and while each had growing colonial interests in the West and East, neither nation could be starved into submission by a blockade. When

the revolutionary war broke out, the relative situations of the two countries had not materially altered. If Canada had passed to England, England had lost the United States, and France still held her magnificent West Indian colony. If French influence in Hindostan was on the wane, Pondicherry was not the unimportant colonial item it has since become; and a very few years previously, the French had deemed it politic to maintain a fleet, numerically more powerful than our own, in the Eastern Seas. As the war progressed, the fleets, trade, and colonial possessions of Holland, combining with those of France, restored any balance which might have been overthrown by the progress of our Indian Empire. Lastly, to complete the picture; if at a later period of the war, England trembled under the excitement of a threatened blow from the camp at Boulogne, La Vendée, at an earlier time, might easily have become the stepping stone of England to a new conquest of France.

6. Thus the dim recollection of the glories of the past, often disinclines us to take that calm and firm survey of the present, which can alone dictate a policy capable of securing "a powerful and "economic imperial Naval Force." History is often allowed to sway us in one way, when, did we adopt its real teachings, it would show that that way was a treacherous bye-path. For in what degree, let us ask, does the British Empire of to-day resemble, in its naval aspect, that of any other country? And how far, with the world against us in arms, could we now adopt the naval policy of the close of last century, or be put to the shifts and expedients of a still earlier naval epoch? In none of her former naval wars did England begin with any tangible superiority in her favour: still less could she claim a monopoly of power on her side. When she won her higher place at the close of each war, she did it by the stubborn daring of her naval leaders, and by the superior moral and physical strength of her seamen. Her forces at any menaced point, seldom exceeded the nominal power of those of her enemies, and when she beat them, she did it in spite of the facts. If she now adventures into a naval war—even with the world against her—she does so with one absolute and one practical monopoly in her favour. In the marvellous constellation of naval stations with which she has spangled the ocean, Great Britain possesses an absolute monopoly of resource. She starts in a war with a connected series of *points d'appui*, which are of overwhelming value, and which cannot be rivalled by the rest of the world banded together. Formerly, the propulsive force of ships was common to all nations. Now that force is unequally distributed, and England possesses it in larger quantity, and in better quality, not only than any single nation, but than any moderate group of nations. The coal-fields of Wales produce a steaming fuel that has no rival, and in her great colony at the Antipodes, England holds alike the control of steam power there. In her iron, her inventive power, and her restless industry, she possesses advantages which may easily be added to swell the list of her superiorities at starting; but these she has always possessed, and has always used in achieving her naval supremacy, so I do not add them. But in her coal she has far more than the mere superiority

which the quantity and quality of her production supplies. Her coal-mines combine with her naval stations abroad to give that second "practical" monopoly of which I have spoken. Coal, before it can become a naval force, must find its way into the bowels of the war ship. England alone possesses the appliances for making this transfer in every quarter of the globe. Her enemies must commonly load with coal in neutral ports, in short measure, and in haste and fear. England alone stores her war ships everywhere within the security of her own harbours. Steam, which in popular fears "bridged the "Channel," in truth and in fact placed in our hands the means of barring every ocean highway to all but British ships.

7. But if the progress of time has submitted these vast powers to our control, it has not failed to add corresponding weaknesses and dangers to our Empire. The power which closed the naval schemes of Napoleon at Trafalgar, was the self-sustaining, self-contained, and self-reliant, eighteen millions of people who lived in the British Islands. However truly the last adjective may apply to the thirty-two millions who have succeeded their ancestors, the two first can no longer do so. In 1813, the British people lived on the produce of their soil. In 1875, that people required *side by side with every pound's worth of raw cotton for manufacture, one pound's worth of raw corn or flour for their sustenance.* In considerations such as the foregoing—which might be multiplied if space permitted—we must recognize one of the great changes in the Empire, since the close of the last naval war. That manufactures and commerce have enormously increased is a well understood fact, but this increase has not so much altered as intensified the conditions which were peculiar to Great Britain in earlier days. The state of the food supply, and the increased population dependent on it, are new elements in the problem, which materially alter the general result. The change is also complete in relation to those outlying colonies of whose enormous value as coaling stations I have spoken. In naval war, under the old conditions, a blow aimed at any of our smaller colonies would have been more dangerous to our prestige than vital to our power at sea. The capture or destruction of a coal depôt on British ground might now inflict a wound which would be well nigh fatal. Deprived of the supply which was absolutely necessary to their value as fighting ships, the British men-of-war in the vicinity must either fly from an inferior force, or yield to it; and the commerce which depended on their protection, must cease to flow.

8. What then is the British Empire in its maritime aspect? It is a vast, straggling, nervous, arterial, and venous system, having its heart, lungs, and brain in the British Islands, its alimentary bases in the great possessions of India, Australia, and North America, and its ganglia in the Crown Colonies. Through this system pulsates the life-blood of the Empire. Main arteries and corresponding veins lead east through the Mediterranean and the Red Sea to India, China, and Australia; west to America and the West Indies; south to Australia, Southern Africa and America, and to the Pacific. Capillaries the most minute, at the extremities of civilization, gather

up the raw produce of the nations, transmit it to the larger channels, which in their turn convey it to the heart. This tremendous organ having extracted all that is necessary for its own sustentation, forces the transmitted produce through the great main channels, and finally through millions of branching filaments to sustain and revivify the nations of the earth to their remotest borders. The life of an empire so highly organized, must hang by a thread. It is no mollusc from whose inert substance huge masses may be detached at will without much effect upon its vitality. It is a living organism whose parts are all inter-dependent, and highly sensitive in their relations. A stab at the heart may put it to death more suddenly, but perhaps not more surely, than the severing of a remote artery, or the wound of a "nerve "centre."[1]

9. Assuming that this picture of the British Empire, its strength, and its weaknesses, is a true one, it is well to put the statement made in paragraph 4 to some closer examination. Do we in fact frame our naval policy in correspondence with the facts of our Imperial position? or, would the course we pursue equally fit Russia, France, Germany, or America? Are we recognizing to its full extent our practical monopoly of coal supply? Are we guarding these "nerve "centres"—our coaling stations—with a clear notion of the effect of a wound there? Are the conditions I have sketched familiar to the naval mind of England? Do they form the ordinary argument of public writers and speakers on naval policy? To all these questions, I think we must give such answers as will confirm my statement. From the complications of a naval policy which is sadly driven and tossed by the wind of the day, we may occasionally extract a fact, a thought, or a statement, consonant with a general system; but the rule is the other way.

Take for instance the invasion scares which every now and then set our wits staggering. I hold that it is impossible for anyone whose habit is to regard our Naval Empire as a whole, to share in them. Let us take reasonable precautions by all means against invasion, when, as in the days of Napoleon, the political conditions are such as to render invasion the chief aim of our enemies. But if our precautions are such as will make the invasion of the United Kingdom more difficult, but will render its BLOCKADE by sea more easy, or leave any of these main arteries or nerve filaments—any of the chief channels of food supply, or trade—liable to be cut or blocked, can it be said that we are recognizing our Imperial conditions? Take again the harbour-defence cry, which at the cost of more than a million, built the "Glatton," "Hotspur," "Cyclops," "Hecate," "Hydra," and "Gorgon;" if it did not go further and share in the designs of the "Devastation" and her successors. The building of powerful ships which are not fully sea-going—which are more or less incapable of maintaining the ocean communications of the Empire—can only be justified on the assumption that the chief danger to it lies at the

[1] For my conception of the empire I am entirely indebted to the writings of Captain J. C. R. Colomb, with whose general principles of imperial defence I cordially concur.

mouth of the Thames, the Mersey, or the Clyde; at Plymouth Sound, Spithead, and the Medway. But if our enemies are to career at will across our lines of communication, while we guard their terminations at head-quarters, what will be left us to guard? Take again the exceedingly persistent struggle to produce "Cruisers" which shall be perfect sailing vessels, as well as perfect steamers, but necessarily sacrificing coal stowage, steadiness of platform, offensive or defensive power. Is this difficult enterprise embarked in with a clear conviction that these ships can always have a coaling station under their lee, an advantage of which their enemies are deprived? It is manifest that if the full rig of any ship be reduced to an insignificant auxiliary, she may be made by so much the more powerful a fighting ship. Our enemies' "Cruisers" will be forced to carry a sail power which is not necessary to us. When we submit our fighting ships to the inconvenience of full rigs, are we not throwing away one of the advantages of our naval position? Note again, the energetic development of the torpedo in which we are engaged. Setting aside the argument as to the relative value of particular forms of this weapon, is its development by us, subordinated to the conditions under which we shall carry on a naval war? The various forms of towing torpedo, as well as the locomotive weapons, tend to make attack cheap, and therefore to put into the hands of a weak and struggling naval power, the means of dealing effectual blows to a powerful navy. Their chief field of usefulness will be from a blockaded port, against the force blockading it. Are we wisely preparing to take the place of the blockaded instead of that of the blockading force? The fixed torpedo is a purely defensive weapon, whose only use is the defence of the land against a superior naval attack; is that to be the position of our land in any part of the world during the next naval war?

But some of the most striking facts as bearing on my view of our defective policy are to be found in our tendency to imitate what our neighbours do in shipbuilding. We built the "Inconstant" to rival an American design,[1] and the "Inflexible" to match an Italian one.[2] We can all remember how pressing our public writers were that we should have a rival to "Peter the Great;" and more recently Mr. Reed has used his powerful pen to urge on us the necessity of building "Popofkas." Why even the well-informed and judicious Council of the Institution could not wholly escape from the prevailing line of thought, and in announcing the subject for the Prize Essay of 1876, they gave war vessels "for coast defence" a prominent place, causing the talented winner of the medal to dash into an astonishing design for a "Popofka," which only an immature idea of the circumstances of our Naval Empire could have produced. In the general lesson which our public writers draw from the American War, I think we can detect similar misconceptions of the teachings of history when applied to our naval condition. No commoner warning is held up to us, than the destruction of American shipping by the acts of the Confederate "Alabama" and her fellows.

[1] See Mr. Reed's statement at the "Naval Architects," 6th April, 1876.
[2] Mr. Barnaby, in the "Times," 27th April, 1876.

It is asserted that our carrying trade is liable to be abolished on the outbreak of a naval war, in precisely the same way as the American flag disappeared from the seas. It must of course be granted that like causes will produce like effects, but it can hardly be allowed that if we are alive to our position, either "Alabamas" will be fitted out in neutral ports, or that "Sumpters" will escape from enemies' ports, for the purpose of preying on our commerce; or that if they were so launched, their lives would be so long, or their acts so fatal, as those of their Confederate prototypes.

The idea of an "Alabama" only arose out of the weakness of the Northern naval force at the outbreak of the war; and her long life and destructive action were due solely to the facts that there was originally no force to withstand or check her; and that when such a force was at last prepared, it laboured under precisely the same difficulties as to supplies—especially of coal—as the "Alabama" herself did. If, however, the conditions of our Naval Empire are only intelligently appreciated, and our naval policy framed in accordance with them, there will be so little hopes of a career for a future "Alabama," that she will hardly be equipped, but if equipped and started, her life will be a very short one. The guards of our lines of commerce will be beforehand with her, and will have the tremendous advantage of home supply, whilst she must seek in unwilling neutral ports, a scanty subsistence. So that though the career of the "Alabama" is really a warning to us, it is not the same kind of warning which it would be to America, Russia, France, Germany, Austria, or Italy. It might be quite right and sound policy in these countries to build "counter-"Alabamas," because the conditions under which they must act will be the same as those of the original "Alabamas," which any one of them might fit out against the other. But it does not follow that a "counter-Alabama" is the true British answer to the possible "Alabamas" of her enemies. On the face of things, it would appear a safer policy to rely on, and fall in with, the great advantages which we stand possessed of in our permanent naval force, and our chain of naval posts whence our forces may draw their supplies.

10. While I thus draw attention to the central figure, round which my subordinate ones are to be grouped, and while I endeavour to show that this central figure, or idea, is not allowed due prominence in the naval pictures of the day, I must not omit to notice a growing tendency towards a better state of things. I have already in a note spoken of the aid I have derived from Captain J. C. R. Colomb's excellent writings, in my general conception of our Naval Empire. His more recent writings and speeches confirm me. In some of the utterances of Mr. Brassey, although in points I disagree with him, I think I trace a truer conception of our naval policy than I have commonly observed. In the papers of Captain Scott, on "the "Maritime Defence of England," including offensive and "defensive "warfare," read at the Institution on the 16th and 30th June, 1876, and in the discussions thereon, there is a great deal which is in accordance with a wide and clear view of our naval position. It shall be my endeavour to add, in however small a degree, to the force of

the current of opinion which seems turning here and there into a truer direction.

11. When, with the conception of our Naval Empire sketched in section 8 of this paper, and of the misapprehension to which we are shown to be liable by the statements in the next section, I find myself called on to proceed, I am met by a question of tremendous importance, the answer to which must dominate my whole scheme. Ought the British Navy to be regarded as an attacking or a defending force? To answer, as is commonly done, that it is a defending force—"Our first "line of defence"—and then to complain that it is not developed as an attacking force, that it failed in Russia as the French Navy failed in North Germany, seems to me most dangerous ground to take up; illogical to a degree, and the parent of wasteful expenditure. If it is a defending force, let it be so developed, and let some other force take up the attack under its guard. It is almost as weak to answer that it is partly an attacking and partly a defending force; such a thought, if invested with the power of directing a policy, will probably produce a Navy resembling some of those ingenious pieces of furniture, which form sofas, beds, chairs, baths, or writing tables, at convenience, but which generally find their most useful functions in the lumber room. On the other hand, to look upon the Navy as an attacking force, is to ignore historical lessons, and few are prepared to support that position.

12. For my own part, I am clear that a "powerful and economic" naval force is only to be obtained by regarding it as strictly a defensive one. In saying this, I do not mean to deny that there are occasions and localities where isolated naval attacks may be made with advantage, but I contend that such things should not enter into the general scheme, and should invariably be met as the expedience of the moment dictates. In a short phrase, I look on the functions of the English Navy as being confined to preventing damage being done to us by the enemy, and to promoting and covering attacks. I think, also, that if history shows us that our Navy was rightly used in former ages to fill these offices, the changes of time have confirmed historical lessons, and made them more powerful than ever.

13. But let me put forward a few of the arguments which appear to condemn those illogical but common views just mentioned.

In those general summaries of Admiralty misdoings, with which a free press so often favours us, it has become a supposed platitude to say that that Board was overtaken by the Russian war "without a "gun-boat," and would now be overtaken by any other war in the same presumed helpless condition. It is perfectly true that we had no gun-boats at the close of 1853, and that we proceeded to build both gun and mortar-boats almost by the hundred, as soon as war was declared. The charge against the Admiralty is, that the Navy was not in 1854, and is not now, prepared as an attacking force. But in answer, it may be pointed out that 1855–6 saw a large naval force specially prepared to attack the enemy; so that not a great deal of time was lost, nor did we suffer in any way from the delay; but also that though much of this intended attacking force got on to its ground, it really

had no effect on the duration of the war. Its one act was the bombardment of Sveaborg, which could not even take rank as a useful diversion of the enemy's force. It is true that work was afterwards found for the gun-boats in China and elsewhere, so that the economic failure was not so great as it might have been. But supposing no such use had been made of the force, the loss inflicted on the enemy by purely naval attacks could not have reached the cost of preparing them.

14. Sveaborg, in fact, represented the only kind of attacks which the Navy has ever made successfully—the bombardment of positions which can be reached from the sea. But we may run through the list of these on our fingers. De Ruyter, on the shores of the Medway, Rooke at Gibraltar, Nelson at Copenhagen, Exmouth at Algiers, Stopford at Acre; these actions are the only ones of any magnitude which were attended with important consequences; and it is remarkable that they were all fought by ships specially designed to defend themselves against ships, or as I should put it, by specially defensive forces. Another case in point on the other side, is the Spanish attack on Gibraltar. Here the attacking naval force was extemporised, and was certainly as powerful as the conceptions of the day could design; but it failed as completely as Nelson's attack on Teneriffe.

15. But when we have admitted the policy of looking on the Navy as a defending force, we must next point out the lines it should occupy; and here I may say that I think public writers fall into the gravest errors when they conceive English waters as the outer lines of an intrenched camp, to be occupied by the Navy, while the body of the place is held by a defending army. Such an idea might more reasonably have obtained at the date of the Dutch wars, and might have been forced upon us by the combined fleets of France and Spain at the beginning of this century. But if the unintelligent memory of the Dutch wars laid us open to siege or invasion from 1797 to 1805, the intelligent memory of that great peril should guard us from ever repeating the error. Insufficient blockading forces at Toulon, Cadiz, Rochfort, L'Orient, and Brest, permitted in 1805 a junction of naval forces against us which our individual superiority at sea alone prevented from being overwhelming. And in what condition, let me ask, should we have found ourselves, had Villeneuve carried out the Emperor's orders, and had he commanded ships individually as powerful as our own? Sir Robert Caldier's action would have terminated in a loss to us; the Emperor would not have withdrawn his troops from Boulogne; and we should have suffered at least—invasion. But these public writers of whom I have spoken wish our Naval Policy to begin now, where it might have calamitously ended in 1805. We are to be prepared, say they, to guard our ports from sudden raids, and our shores from permanent occupation. Vast systems of "Harbour Defence," by torpedoes, by rams, circular ironclads, and "Staunch" gunboats, these ought to be the very important, if not the chief objects of a true Naval Policy. The "protection of "our commerce" is to be attained by fast cruisers, who shall meet and

destroy the fast cruisers of the enemy, just as the "Kearsage" met and destroyed the "Alabama." For fleets? Well, these writers have a strong notion that their time has gone by, and they say very little for them; while as to the blockade and the preparation for it—it is an old world notion necessarily to be abandoned in these days of steam and electricity.

16. Summarised, the rather vague policy recommended to us may be put thus into four theses. (1) The shores of the British Isles must in the first instance be preserved inviolate by a naval force close to them. (2) The cruisers of the enemy must be met and beaten at sea. (3) The enemy's fleets *may* be met at sea, and if so, should be beaten. (4) Some kind of naval force especially designed for attacking the territory of the enemy should be always kept in readiness. I am not sure whether those who are in the habit of advancing these theses separately, would admit that I correctly enunciate them now that I have placed them together; nor, on the other hand, am I sure that some of those who may read this paper will not commend the summary as the indication of a true policy; but it is in the advancement of such views, either separately, or together, that I see the strongest instances of a disinclination to investigate and accept existing facts, and to act in subordination to them. If there are any who altogether deny that I rightly state prevailing opinion, either as a whole, or in its separate branches, I would ask them to turn generally to the writings of the day, and to see where, and how often, the idea of blockade, or of fleets of observation, shows itself present in the minds of the authors. Also, whether the harbour defence ship, and the swift, unarmoured cruiser do not, with the torpedo vessel, almost entirely divide the empire of their opinions on naval construction?

17. Having thus set forth what would, in my view, be the wrong developments of the Navy, considered in its true light as a defending force, let me state what I consider the right development. It appears to me that our Navy has two, and only two great defensive functions to fulfil, namely, (1) to keep the enemy in his own ports, and to stop his supplies thither; and (2) to keep open the great sea-routes to and from the heart of the Empire—the Islands of Great Britain. If after these things are fully provided for, anything else remains to be done, certainly let us prepare for it in peace time; but I cannot imagine that anything else need be done, or in fact, would be done, if these offices of the Navy were completely filled, until we had to deal with an enemy as practically beaten at sea as Russia was when war began in 1854. Then indeed we may expect popular cries for naval *attacks* on the enemy; then indeed we may expect to see them made with materials hurriedly designed and brought to bear; but at least the statesman of such a day will be bound to consider these attacks as mere diversions, quite apart from the main purpose of the imperial effort.

18. Whatever functions the Navy may be expected, in the minds of those who busy themselves about it, to fulfil, it is certain that one of three views will prevail in dictating the method to be pursued in peace time. Some—chiefly those who are, and expect to remain

irresponsible—will be for modelling the whole Navy from first to last on a theory of probable war, and probable requirements then. Others —chiefly those who are so pressed with carrying out detail and the current work of the Navy now, that they have little or no leisure to look into a problematical future—will devote themselves first to the current wants of the day, secondly, to meeting the current opinion of the day. It is exceedingly unlikely that they will, or can go further. But those who have more leisure for thought, and are not so office-driven, will reflect that "a powerful and economical Imperial naval "force" must grow in a constitutional soil, and under constitutional skies, which are both in themselves adverse to the production. The soil must be manured and worked, and the weather cheated, or the plant cannot be developed. In plain words, under the will of a popular assembly, very much driven by the eager but uninstructed opinions of the least informed and most pre-occupied of the people, the greatest caution is necessary not to push a theory of naval force too much into prominence, but having carefully mastered the broad principles of the proposed development, to carry them out in apparent subordination to the requirements of peace. England never has yet, and never will be sufficiently long under the dominion of a single set of minds to carry out a grand scheme of preparation for war in its entirety. I think it is the duty of an essayist to remember this leading fact, and consequently my next position is that the demands of peace should be in the first instance provided for. But while I lay down this dictum, I couple it with another. Not a single ship should be built which did not designedly occupy her place in the great scheme of preparation for war. It may be said that these things are not compatible, but I hope to show that we should have to submit to very slight inconveniences in peace time after all, while we gained the much greater object of being READY when war came.

19. Now let us observe on what clear ground we stand if we follow out the course prescribed up to this point. In the first place, we are taking for our basis only what actually is; we know for certain the geographical conditions of our Naval Empire, and we know exactly our naval wants in peace time. We are to combine these two clear, undoubted facts; our peace ships are to be built for our peace wants, but we are to see that above and beyond this, they will fall immediately into their places on the declaration of war: but only—and here is an important point—only as defensive weapons, and to preserve the naval status of the Empire, while it makes its attacks by other means. Unless we are prepared to say that the peace public ships and the war public ships are essentially different, the principle laid down will only call on us to strike out from the design of the peace ship all those elements which may prevent her taking part in the great scheme when the time comes; and to add such things as are wanting. Next, we banish from our minds all vague and indefinite notions of naval attacks, and we say in effect, "we maintain a free sea "in peace time: nothing whatever is to be thougbt of the Navy at war, "but this maintenance, until it is so secure that we have leisure and "opportunity for special efforts in other directions." But it is evident

that over and above the Navy which is kept up in peace by the direct pressure of a public opinion, largely moulded by the heads of commercial houses whose smaller agencies abroad carry on their business under the active protection of Her Majesty's Ships, the country has hardly ever shown itself averse to a moderate expenditure on classes of ships not directly concerned in commerce-protection in peace times; here our hands are freer, and these ships can be constructed directly and entirely with a view to further defensive war.

20. It is on broad and simple bases such as these, that I am prepared to rest my scheme for the "development of Great Britain's Mari-"time Power," and it will be found as I go on, that I shall advocate what may be thought startling changes: but that such as I do recommend, will be in entire subordination to these great principles, and will be backed by the logic of facts.

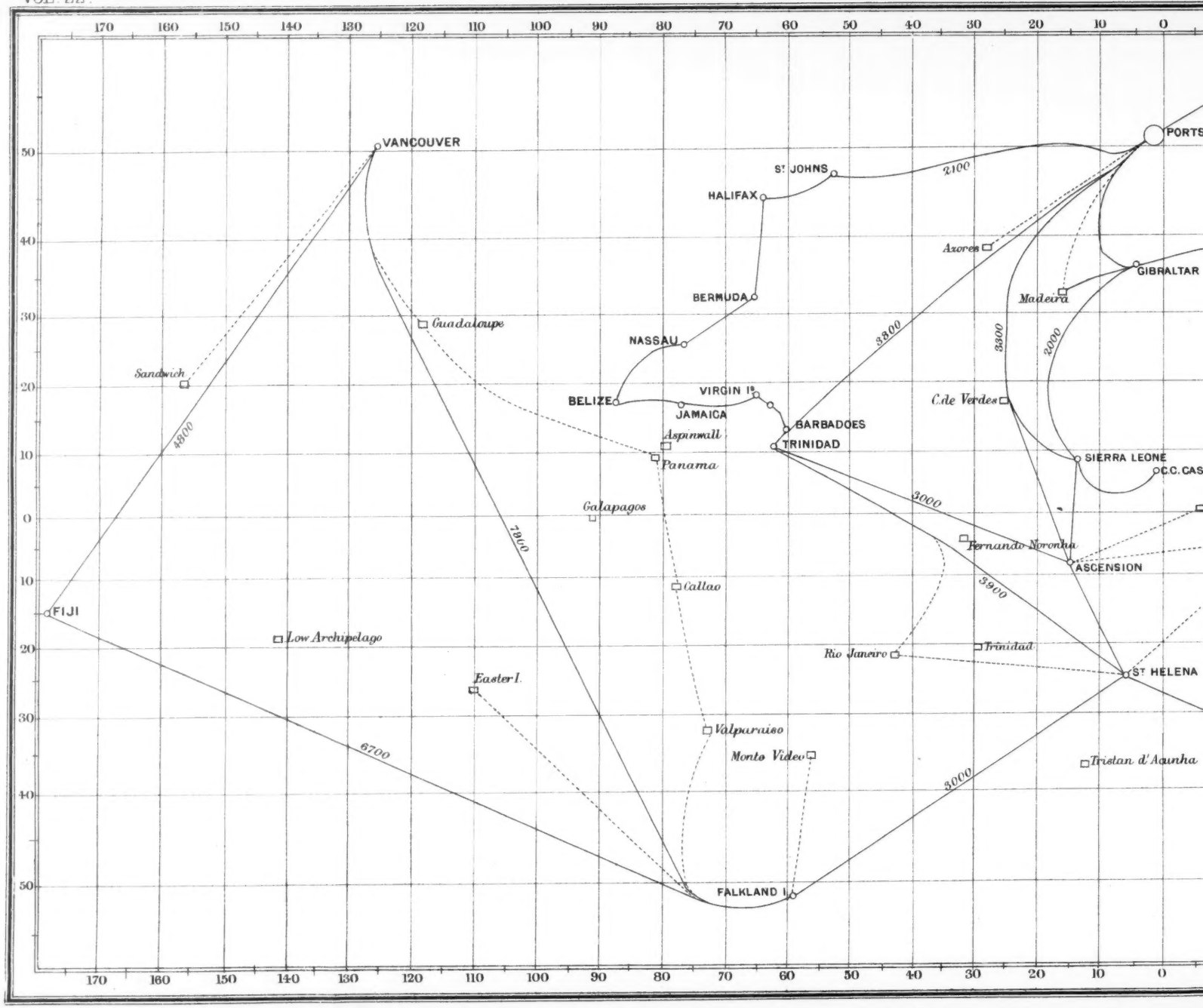
21. Turning now from the statement of general principles, to their application to the facts, we must look at the actual geographical position of our Naval Empire, and note what lines of communication it is imperative to maintain, and on what *points d'appui* the necessary forces are to rest. This survey will give us some idea of our probable requirements in war so far. We must then turn to an examination of our naval force actually in commission, and its geographical distribution. If we draw a comparison between these forces—that probably required in war, and that actually required in peace, we shall readily arrive at some conception of the modifications—if any—proper to be introduced into our peace establishment in order to make it economically valuable for war service. Finally, by assuming a case of war between England and a combination of naval powers as large as may be reasonably expected to appear in arms against us, we shall arrive at some conclusions as to the nature and extent of that force which should undertake the duties of blockade, or of meeting masses of the enemy at sea, in the event of our imprudence in peace time leaving us with incomplete blockading forces on the outbreak of war; or, which is perhaps as probable, in the event of its being necessary to open the war with a fleet action. In all these estimates of our requirements, we are, it is to be observed, to base our views on a series of facts as follows:—

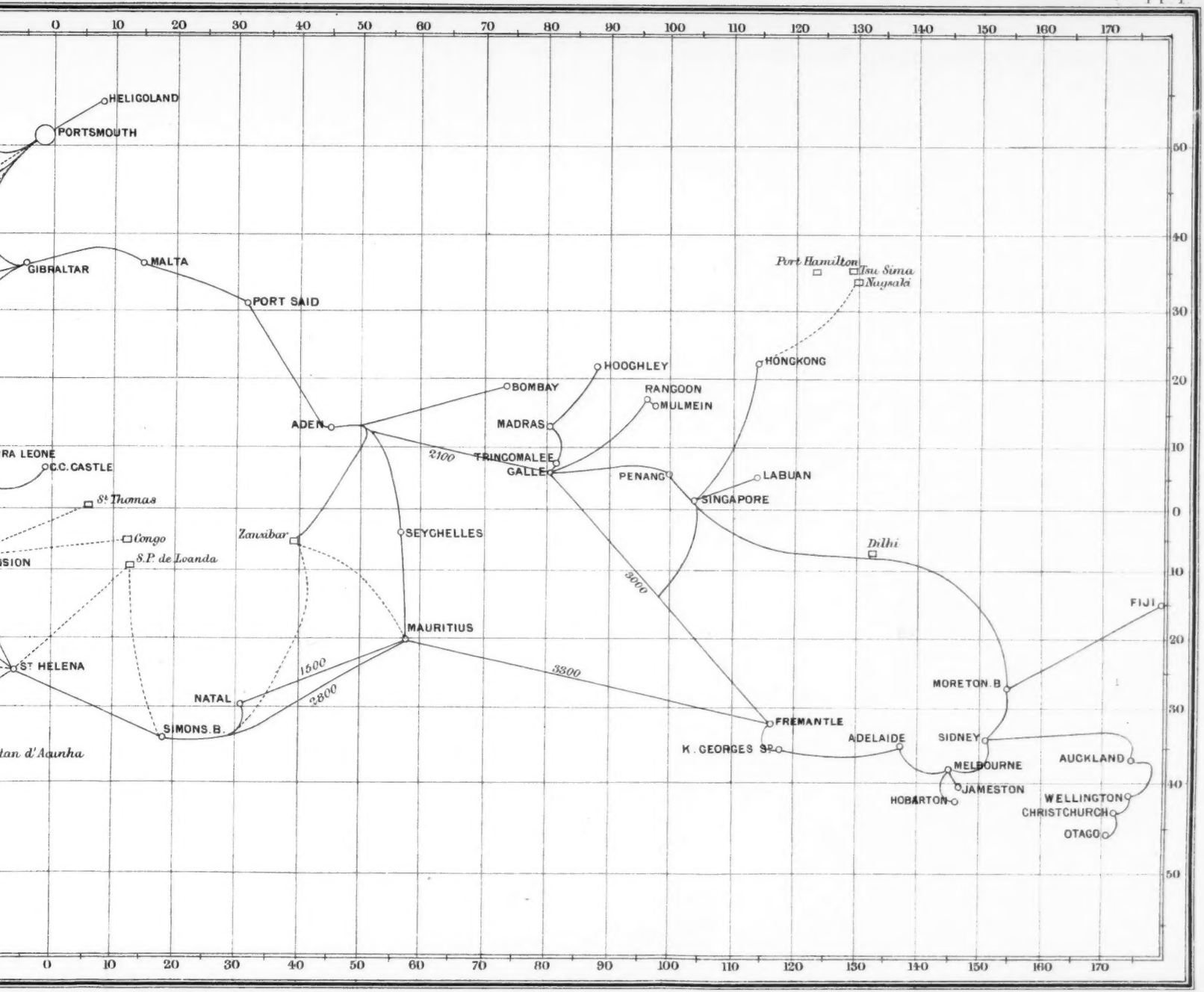
(1.) The Geographical condition of our Naval Empire.

(2.) Our actual peace Navy.

(3.) The Geographical condition of a possible naval combination against us, and the nature and distribution of neighbouring naval forces.

It is, I conceive, almost impossible to arrive at very erroneous views if this method of argument is steadily pursued. The result will be to show us in general terms the classes of ships, and the relative proportions of the classes necessary at the outbreak of a great war, whence we can deduce rules to be followed in providing our peace Navy. We can afterwards descend to those questions of propulsion, armament, and defensive arrangements, which should rule the construction of each type, and so conclude our consideration of the two chief heads set forth in the Council's memorandum, namely, our


VANCOUVER
FIJI
Sandwich
Guadaloupe
Low Archipelago
Easter I.
Galapagos
Panama
Aspinwall
Callao
Valparaiso
Monte Video
FALKLAND I.
Rio Janeiro
Trinidad
Fernando Noronha
Tristan d'Acunha
ST HELENA
ASCENSION
SIERRA LEONE
C.C. CAS
C.de Verdes
Madeira
Azores
GIBRALTAR
PORTS
ST JOHNS
HALIFAX
BERMUDA
NASSAU
BELIZE
JAMAICA
VIRGIN Is
BARBADOES
TRINIDAD
4800
7900
6700
3000
3900
3300
2100
2000
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
10 20 30 40 50


0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
HELIGOLAND
PORTSMOUTH
GIBRALTAR
MALTA
PORT SAID
ADEN
BOMBAY
HOOGHLEY
RANGOON
MULMEIN
MADRAS
TRINCOMALEE
GALLE
2100
PENANG
LABUAN
SINGAPORE
HONGKONG
Port Hamilton
Tsu Sima
Nagasaki
RA LEONE
C.C. CASTLE
St Thomas
Congo
S.P. de Loanda
SEYCHELLES
Zanzibar
Dilhi
3000
MAURITIUS
FIJI
ST HELENA
1500
3300
NATAL
2800
SIMONS B.
tan d'Acunha
MORETON B.
FREMANTLE
ADELAIDE
SIDNEY
K. GEORGES SP.
MELBOURNE
AUCKLAND
JAMESTON
HOBARTON
WELLINGTON
CHRISTCHURCH
OTAGO
10 20 30 40 50

J. Jobbins

"Fighting Ships, and the Protection of our Commerce;" afterwards we can take the minor points of the "Naval Volunteer, or Supplemental Force," and our "Colonial and Home Defence,"—the latter being, as will be observed, really provided for, as far as naval forces go, in my general scheme.

22. We may now turn to the chart of our Naval Empire which I have prepared. In it I have omitted all reference to the continents enclosing this Empire, because it is sufficiently evident that if we can succeed in preserving the chain of communication between the different naval stations unbroken and free, we by this act preserve our mainland from naval attacks, and need not therefore concern ourselves with them.

23. As before observed (Par. 8), the chief arterial and venous trade routes are five in number, and run east through the Mediterranean to India, China, Japan, and Australia; south to Africa and South America, and round the Cape of Good Hope, or by the Straits of Magellan, and Cape Horn; south-west to the West Indies, and the Isthmus of Panama; west to the United States and Canada; and north-east to the Baltic. The existing nervous system, which in war time must govern and protect the commercial routes, is shown by black lines on the chart. Each line connects two possible naval stations on British territory, which are shown by the small circles with a dot in the centre. These circles are not in all cases naval stations properly so called, but at least they are, or can be made, coaling stations, if not regular depôts. It will be seen that there is another imperfect network of dotted lines connected with small squares having a dot in their centres. These squares represent ports belonging to the smaller powers, which might, in my opinion, be used in time of war to supplement our existing system of depôts where it is defective; ports belonging to the larger states cannot well be considered in this category, as with any of these we might be at war, and when at war with any of them, is just the time our Naval Empire would be imperilled. At such a time, however, we are eminently in a position for alliances with the smaller maritime states, as we threaten them all simply by the position we actually hold, and in consequence of that position, we are more able than any other nation to offer them protection and advantages. These plain lines therefore represent the nerves of the Empire, as it is along them that the force necessary to protect our commerce must flow. The stations at the extremity of the lines are the ganglia, where is stored up and reserved the nerve-force brought into play by the war ships. Whenever these nerves or naval routes, with their corresponding ganglia or naval stations, lie directly side by side with the main commercial streams, and where the stations are sufficiently close to each other, there our Naval Empire is in a state of geographical perfection; where, on the other hand, the naval routes lie apart from the commercial highways, and where the naval stations are few and far between, there the danger is most imminent, and the difficulties of preserving the trade routes intact are greatest. But the importance of these dangers and difficulties does not rest on such geographical considerations; it rather depends on the extent and

nature of the trade passing over the routes in question. A route over which food for the mother country passes, is more important than any other over which no food passes; and of any two routes over which no food passes, that is the most important over which raw materials are conveyed, provided the other does not greatly exceed it in value. According to the "Stateman's Year Book" for 1877, and taking the figures quite roughly, as is proper in an essay of this length, the eastern trade route is as important as any in money value, as the commerce beyond the shores of Egypt alone may be taken at £150,000,000 annually, to which all the Mediterranean and Black Sea commerce must be added. Supposing one-third of this to go round the Cape, the eastern route beyond Egypt would stand at £100,000,000. The southern routes take perhaps £50,000,000 to the Cape of Good Hope and round it; while perhaps £12,000,000 goes round Cape Horn or through the Straits of Magellan. These two routes coinciding in the Atlantic, make the southern route in value £62,000,000. But, as much of the import from the Pacific is bread-stuff, and much of that from Australia is raw material, wool, &c., this southern route, with the West African and East American produce and import, will not be less valuable than the eastern route. The south-western route taking in the Panama trade, may perhaps stand for £20,000,000. The western route to the United States alone is put in the "Year Book" at £91,000,000, or, with Canada added, £110,000,000, but as some of the trade goes over Panama, and some round the Horn, the western route may be valued at perhaps £100,000,000, of which the chief part is food and raw material. The north-eastern route may be worth £80,000,000, of which the greatest part is food and raw material.

24. Without attempting to do more than sketch a basis for argument, I should be inclined to place the eastern route first in the scale of importance; the western next; and then the southern, north-eastern, and south-western.

25. Taking therefore the eastern route first, we observe that everywhere, from England to Hong Kong the naval route coincides with the commercial one, and moreover, the greatest distance between any two naval stations is that between Aden and Galle—a little over 2,100 miles—while the central point of that route is but 800 miles from Bombay. But this route is peculiar, inasmuch as it passes through territory not belonging to great Britain; but if the passage is to be made at all, Suez and Port Saïd must be considered to all intents and purposes as British naval stations. By alliance or otherwise with Egypt, England must have the control of the canal not as a neutral passage, but as a place were her war ships may replenish as in their own ports. A close alliance with Egypt is therefore, in war time, one of the first and earliest methods of protecting our commerce. But this route is geographically defective, inasmuch as the commercial route is prolonged very much beyond Hong Kong to the north, while the nervous system ends there. China is perhaps not sufficiently advanced to give us trouble by proclamations of neutrality, but Japan would be very likely to do so, and with Russian hostile or neutral ports to the north, our commerce might suffer. It must be under-

stood that we are not only concerned to keep these trade routes safe and free, but the mercantile mind must be assured of both, or commerce will shrink away. It would therefore be very desirable that either from Japan, the Corea, or China, some spot of territory should be obtained which is capable of being converted into a naval depôt. Places perfectly suitable are Port Hamilton, south of the Corea, and belonging to it, and the Island of Tsu-Sima belonging to Japan. As far as Hong Kong, this eastern route may be said to be geographically perfect, but if its geographical advantages are not taken full advantage of, the commercial stream is liable to menace from three quarters. France at Saigon and Pulo Condore lies directly upon the route from Singapore to Hong Kong. Spain at Manila, occupies a like position to the eastward; Holland might menace the Straits of Sunda and of Malacca, those two narrow channels through which, as through great railway junctions, the trains of goods must pass and repass, to and from China and Japan. Were those three countries to become hostile to us, the blockade or destruction of Saigon, Pulo Condore, Manila, Sourabaya, and Batavia, would probably be found imperative to avert paralysis of the China and Japan trade. When from Point-de-Galle, the commercial route, instead of going east, or north-east to the Indian ports, passes south-east to Fremantle, King George's Sound, and so to the other Australian and New Zealand ports, we come to a run of 3,000 miles between two naval stations. And this route is capable of being threatened along its northern part by Holland, issuing from her ports from Acheen in Sumatra to Koepang in Timor. Holland would be therefore our greatest danger in the Eastern Seas, did she become hostile; and in the politics of Europe there seems to me no change more perilous to England than that which would attach Holland to the German Empire in a war between it and the British nation. From the centre of the route from Galle to Fremantle or King George's Sound, Singapore lies 1,100 miles. But without the command of the Straits of Sunda, Singapore would be difficult of access. The war ships protecting this route might have to depend for supplies on Galle, and on Fremantle or King George's Sound, each not less than 1,500 miles from the centre of the route, which might be menaced from points not 600 miles distant. If Holland were inimical, and the blockade of her ports in the Sunda Islands incomplete, it might be advantageous to alter the route to Australia, and to pass by Aden to the Seychelles and the Mauritius. The only European power capable of menacing this route with advantages corresponding to our own, is France; but Bourbon in the immediate neighbourhood of Mauritius would not be a safe port of issue for ships hostile to England, and the possessions of France in Madagascar and its islands might be kept in check by our ships resting on such bases as Zanzibar and Johanna, or ports in Madagascar itself, for these are just the states to become our natural allies in universal war. After leaving King George's Sound, the eastern commercial route becomes again geographically perfect, until its extremest limits are reached in Fiji, which a far-sighted policy has united to the British crown. There is but one more commercial route to trace in this part of the world, that namely through Singapore

and Torres Straits to our Australian possessions. This route of about 3,600 miles is at present, I believe, destitute of naval stations except at its extremities. In war it could be menaced by Holland with advantages on her side, but on the other hand, naval stations might be established at a point or points along the more eastern part of the route, which would remove our disadvantages. Already in the possession of that superior fleet which we now have, and are bound to keep up along any threatened route, we want no more than smooth water anchorages for our bases of operations, and having them, our local superiority can be maintained; without them we suffer a theoretical disadvantage which becomes a very real one if our enemy on the spot is in possession of such bases.

26. On the whole it is to be observed of our great eastern lines of commerce, and its protecting nerves, or naval routes, that there is nowhere a distance of more than 3,300 miles to be traversed between any two naval stations, or points available as naval stations. If the wind is regarded as a neutral, blowing as hard and as long one way as it does the other—giving a ship all its help one time, and all its resistance at another time—then it follows that such a ship starting with as much coal in her bunkers as will carry her at a given speed 3,500 miles, will be efficient to guard any "nerve" of the eastern part of our Naval Empire. She could steam to the middle point of the "nerve," fight an action there, and return either to the naval station she started from, or pass on to the naval station at the other extreme. She could very securely do this if she made an alliance with the wind, and so arranged matters that when it was foul, it should do her a minimum of harm, and when it was fair, a maximum of benefit. We thus see that the propulsive power of a war ship must be regulated by the geographical conditions of her service; and if we find that the geographical conditions of the British Naval Empire do not, in any part of the world, greatly differ from those just discussed, we shall also find that the propulsive power of our war ships may be governed by a uniform law. If on the contrary, we find that there are commercial routes requiring protection where it is impracticable to draw the naval stations within 3,300 miles of each other, we shall have to ascertain whether it is better to protect those routes by means of ships with special arrangements for propulsion; or whether the whole standard of propulsive power should be raised.

27. We now come to that commercial route which in par. 24 is roughly estimated as next in importance to the eastern, namely the western. There are no naval stations existent guarding this route and nearer to its middle point than St. John's Newfoundland, Halifax, Bermuda, and Nassau. On the other hand, there is no foreign naval station more capable of threatening that route than the Azores. But the Azores, unlike Java, Saigon, and the Philipines, are not to be looked on as a possible inimical naval station. On the contrary, one of our first acts, when the western route is threatened, must be a renewal of our old alliance with Portugal, giving us the command of the Azores as a naval station. Again, St. John's, Halifax, and Bermuda, lie almost on the western trade route, and no foreign territory except the

United States themselves would enter on war with more local advantages over the route than our own. In a war with the United States, western trade routes cease south of Nova Scotia, while to interrupt the northern routes to Canada, the United States have not the geographical advantages which we have for their protection. In a European combination against us, our enemies have no such grasp of the western routes as we have, and only the possession of the Azores could place them at all on a par with us. But as I have before said, the Azores can never be regarded as a menace to us so long as Portugal remains in possession of them. The western routes are therefore geographically perfect, and as the longest distance between any two naval stations is 3,200 miles (that between England and Bermuda), the propulsive powers of the war ships guarding the western routes may be identical with those necessary for guarding the eastern.

28. We next come to the southern route. A stream of commerce which sending branches east and west to Africa and America, parts in the South Atlantic into two great channels of trade—the one going round South Africa to join our eastern network of water carriage, the other passing round South America to dissipate itself along the whole line of American western coast until it reaches its source and terminus in British Columbia. Unlike the great eastern and western traffic, which is mainly conducted by steam power, and where the outward and homeward routes in consequence nearly coincide, the southern traffic is mainly conducted in sailing ships, and the routes do not wholly coincide. The outward route keeps to the eastward, north of the line, and then passes westward, south of it; that stream which rounds the Cape of Good Hope, not turning east until it has reached a considerable southern latitude. The homeward route from the east, on the other hand, passes close to the Cape of Good Hope, close past St. Helena and Ascension; at or near the line the western stream from South America and Cape Horn joins it, and the volume of traffic thus increased, trends away to the westward, and finally flows home north and west of the Azores. Ships guarding the northern portion of the outward route, must at present rest on the Home ports, on Gibraltar and Sierra Leone, the two latter lying perhaps 1,000 miles from the main stream. The only foreign territories on which forces hostile to this part of the route could rest, are Madeira, the Azores, and the Cape de Verdes, all belonging to Portugal; Cadiz and the Canaries, belonging to Spain, and the Gambia, belonging to France. But according to my view, Madeira, the Azores, and the Cape de Verdes, must be regarded as closely allied naval stations, open to our ships to the full extent, but closed to all who had designs on our great southern commercial route. Looked at from this point of view, the route to the line outward is geographically as defensible as the eastern route; there would be no spot along the route much more than 600 miles from a base, and ships stationed here with 3,500 miles in their bunkers would rarely be in alarm as to their coal supply. Deprived of the bases furnished by the Portuguese Islands, we should be, though still in a better position than any possible enemy not resting on those bases, yet still not so well off as

might be desirable. Our ships resting on Sierra Leone and Gibraltar must calculate on operating at 1,200 miles from either station; that is, they must be prepared to steam to a spot 1,200 miles off, fight there, and return, or steam another 1,200 miles in a different direction. That is, their coal supply must exceed that necessary to steam 2,400 miles. But in discussing the coal supply necessary for a ship protecting the great eastern routes, we allowed a steaming capacity of 3,500 miles; therefore any ship whose propulsive power is based on the necessities of the eastern routes, is so far competent to deal with the northern part of the outward southern route, even if she is deprived of her very probable coal depôts at Madeira, the Azores, and the Cape de Verdes. The northern part of the homeward southern commercial route is not geographically so convenient for defence as the outward route just treated of. There is a point in that route in latitude 30° north and longitude 35° west, which is nearly equally distant from all the English naval stations surrounding it, or, speaking quite roughly, 1,600 miles from St. John's, Bermuda, Barbadoes, Sierra Leone, and Gibraltar. That is, if there were no alliance with Portugal, our ships might have to steam 1,600 miles to that spot, fight there, and return 1,600 miles, making in all 3,200 miles. But after all, we are no worse here than we were in the far east, (paragraph 25), and the propulsive power of coal for 3,500 miles found necessary there, would be a sufficient supply even for this extreme case. But including as usual the Portuguese Islands of Cape de Verde and the Azores as our assured friends, there would be a quadrilateral of coaling stations, none of which were more than 1,100 miles from the most distant point within it. So that a ship furnished with 3,500 miles of coal, might go to the centre spot, and cruise, or lie there till she had spent nearly half her remaining coal, before she was called on to return for replenishment. On the other hand, setting Portugal aside, there is no power in so good a geographical position for attacking this route as we are for defending it.

29. South of the Line, no European State is geographically as well prepared to interrupt our lines of traffic as we are to secure them. Brazil, indeed, and the Southern States of South America, would, if hostile, seriously menace geographically the whole of the route south of the Line to the Pacific, and the northern portion of that to the Cape, and the Indian Ocean. But I think that these States must be regarded as either neutral or friendly. If allied with us, which would be their natural condition with their commerce at our mercy, all our routes in the South Atlantic would be practically secure. If neutral, our bases of operation must be Ascension, St. Helena, Simon's Bay, and the Falkland Islands. This quadrilateral is so much larger than the northern one spoken of in a previous paragraph, that there is a point within it, perhaps 1,800 miles from any English naval station, and supposing the South American States inimical, there would be some difficulty in protecting from such distant points, the outward traffic to the Cape of Good Hope, and both outward and homeward traffic to the Pacific, seeing that the track lies along the hostile coast. But here it is not impossible that nature has placed at our command

the means of meeting these difficulties, and of establishing a geographical control over this part of the ocean, sufficient for all practical purposes, even without alliances. A hostile Brazil would place Fernando Noronha at our discretion. Further south is Trinidad, with an anchorage, which though described as "unsafe" in the old days of sailing ships, might not be unavailable to the modern men-of-war as a coal depôt. South-east again lies Tristan da Cuna, with its "abundance of vegetables, bread, bacon, eggs, butter, milk, poultry, "beef, and mutton." This was a British naval station in 1815, and clearly might, at a time of pressure, come under its old rulers. True the anchorage remains marked "unsafe," but steam and chain cables have not been without their influence on the safety of anchorages. Trinidad, Tristan da Cuna, and the Falkland Islands, form a triangle within which there is no point at a greater distance from one of the three others forming it, than perhaps 1,200 miles, and therefore, with the coal supply premised for ships guarding the eastern route, the South Atlantic routes might also be guarded, even without alliances: but much more easily with those which would in all probability be made. The homeward route from the Cape may be dismissed in a sentence. It coincides with the nerve running from Simon's Bay through St. Helena and Ascension, and as these stations are not 1,500 miles apart, the geographical command of the track is complete. When we follow the eastern branch of the South Atlantic commercial stream round the Cape, we find a nerve 2,200 miles long, running from Simon's Bay to Mauritius, which may be broken at Natal, so that the longest nerve should not exceed 1,500 miles. At Mauritius we connect with the eastern nerve system which has been already discussed.

30. The western branch of the great southern trade route passes into the Pacific and follows the coast line to the north. The nerve system here is the most defective of any, and it is evident it cannot be preserved unbroken without alliances, or a class of ship altogether more fully provided than those which are capable of guarding the routes already treated of. There is nowhere in the world so large a space of ocean unstudded by British possessions, as the great triangle formed by the Falklands, Fiji, and Vancouver's Island. Nor are there within that space many points which are suitable for being converted into naval stations. There may be some spot in the Low Archipelago capable of affording a moderately smooth-water anchorage, and perhaps Easter Island might become a depôt as a temporary expedient; but France and America already possess the Pacific Islands most eligible for affording support to ships operating within the triangle. On the other hand, the whole of the American Pacific States south of Mexico, are so situated, that their interest would lie in an alliance with that power which had the chief command of the sea. It appears to me that on such alliances the safety of the eastern Pacific trade route must rest. If these alliances were not contracted by us, inimical European Powers would at least meet us in the Pacific on equal terms, a thing which it is of vital importance to us to prevent. Neglect on our part to form these alliances, and to place a suitable force in the Pacific to rest upon, and at the same time to sustain them,

would indeed leave our trade route open to the attacks of hostile "Alabamas," and would practically leave us no other resource but "counter-Alabamas," a state of things which would undoubtedly cause the disappearance of the English flag from those waters. Mexican ports might be less open to us than those more to the south, for if the United States were mixed up in the war, they would be able to bring pressure to bear on Mexico by land, and so force her into neutrality. In a European war, in which the United States were distinctly neutral, Mexican ports would be available to us so long as we held the sea on both her coasts. The Sandwich Islands being quite at the mercy of the power holding the sea, might also be calculated on to sustain that power, and so remove some of the defects exhibited by the Pacific as a British nerve-system. But I hold it futile to attempt the defence of the Pacific trade route by any description of vessels which must rest for their supplies on Vancouver, Fiji, and the Falkland Islands. With a friendly coast from the Straits of Magellan to Panama, I do not think it is so difficult to defend the trade routes of the Pacific with ships of the propulsive powers designed for other parts of the world. Were the United States hostile, and did they carry Mexico with them, the Island of Guadaloupe, with a moderately sheltered anchorage, lying directly in the track from Panama to Vancouver, might be made available as a depôt, and would reduce the length of the nerve to one quite under control.

31. The north-eastern commercial route, and the method of preserving it intact, do not require much discussion. It is liable to interruptions only by the Great European powers, and we know by experience that so far as Russia is concerned, naval forces resting on temporary bases in the Baltic are quite competent to preserve it. The forces necessary to blockade those ports whence might issue our enemies' "Alabamas," would by the act of blockade preserve the trade route intact.

32. There remains now only the south-western route, that to the West Indies, to be dealt with; but a glance at the chart will show that practically we have already done so. When the means are provided for protecting the southern and western routes, that which lies between them is already protected. Once past the line joining Bermuda and Barbadoes, the British traders come into a perfect network of naval stations, all close together, and offering a system of naval bases not equalled in any other part of the world.

33. We have now fairly examined the whole of the marvellous chain of posts which constitute the strength of the British Naval Empire. We have seen that, depending on British territory alone for supplies, ships capable of steaming at a given moderate speed for 3,500 miles, may everywhere, except in the Pacific, pass from point to point under steam alone. In the Pacific it is seen that, either ships must be independent of coal supply, or they cannot operate when resting alone on British naval stations; but we also know that to be without coal supply is to lay the whole trade route open to depredators of the "Alabama" class. We see also that everywhere on our trade routes there lie either the territories of small States capable of alliances

offensive or defensive with us, or else those desolate spots which, turned into coal depôts, become all that we require. Our great conclusion therefore is, that our Naval Empire depends upon coal supply: that capacity for coal stowage is the first requirement of a British man-of-war. That she must use the wind as an auxiliary only—to be cheated when foul, and to be used when fair. Such, we see, must be our "propulsive policy," while it can be that of no other nation at war with us. No other nation has these coal depôts under her lee even if she had the coal to place in them—and all other nations must therefore, in attacking our trade routes, reverse our propulsive policy. They must have great sail power, and their steam must be reserved for fighting purposes. It appears to me impossible for such ships to seriously attack commercial lines guarded by other ships practically independent of the wind; though they would of course meet British ships depending greatly on sail power on an equality.

34. The study of our geographical condition, therefore, determines the ratio which steam is to bear to sail power, and determines it altogether in favour of the former. If 3,500 miles was an impossible coal supply for a ship, then indeed our geographical studies would not have led to much; but we know that if all other things give way to this one quality of coal-carrying capacity, there is no difficulty about it, and I should myself put 4,000 miles at 5 knots, as the least amount of coal stowage proper for an English man-of-war.

35. But before leaving finally the geographical part of my essay, it is worth while to note how a sort of destiny has possessed us not only with a command over all the great commercial routes, but with the GATES of these routes. Egypt, it is well understood now, is tied to us by bonds of friendship and interest, and gives us the gate of the Red Sea route to the East; we already hold the gate of the Mediterranean, and the outer gate of the Red Sea. Galle is the gate leading to the east and south-east trade routes. Singapore, that of the China and Japan highways. The Cape of Good Hope forms the gate of all eastern trade routes in the southern hemisphere; while the Falkland Islands command the gate of all western roads by water there. Possessed of these gates, how are enemies to pass them? If they do pass them, what hopes are there of success against our trade, so long as we hold our chain of posts intact, with sufficient maritime forces resting on them? The answer is clear—None.[1]

36. But I have set out with a statement, or a promise, that my scheme for war purposes would rest on our peace requirements, and that the two things are not so antagonistic as they might be thought. Here I may be asked how I am to reconcile the tremendous expense of a fleet depending almost wholly on steam power with peace estimates? In answer, I deny the "tremendous expense," and I assert that it is more than probable that a peace fleet formed on the principle that sail power is the merest auxiliary, would be cheaper than the present one is, where in most cases steam and sail fight for the mastery.

[1] It will be clearly seen that up to this point I have done little more than amplify the views of Captain J. C. R. Colomb on "Imperial Defence," taking—as I am bound to do—the more naval view of the question.

This is a question of facts, and although I have not space to give all the facts, I can give as many as are necessary to prove my case. In the first place, let it be laid to heart that the estimate for coal to be purchased by the Admiralty was, for 1876, but £113,000; while raw hemp, canvas, and some minor articles of like nature, were expected to cost £123,000. Next, I must point out that I have made a very close examination of the economical results of sail power, as applied to an ironclad, through two years' service, and to a gun-vessel through some 15 months. I should state that the ironclad had a sail area equal to four square feet per ton of displacement, while the gun-vessel had 16 square feet. As to the ironclad, I found, I think beyond the possibility of doubt, that her masts and sails cost the country, partly in coal, partly in wear and tear, and partly in interest on capital, not less than £2,000 a-year over and above what the ship would have cost had she been entirely mastless. As regards the gun-vessel, I traced her minutely over a voyage of 6,100 miles, of which only 1,800 were done under steam, with or without sail, and 4,300 were done under sail alone. The wind was fair and strong for more than seven-tenths of the voyage, and the foul winds never exceeded the force of five. Under such circumstances, the resort to sail only, *delayed her voyage* by about 14 per cent. Supposing she had had no masts or sails, that the fair wind would not help her in any way, and that the masts and sails as existing did not in any way retard her when the wind was foul; then it is possible to say that this ship, while reducing her speed as above, did actually save 60 per cent. of her coal on this particular passage, so very favourable to such result. But being here concerned with the money cost, we must ask several questions. Suppose the ship, even as she stood, had steamed at the reduced speed forced on her by the resort to sail, would she not have made a probable saving? Can we truly say that fair winds, even without any sail, do not make an economy on coal? Is it not true that masts and yards do in fact greatly retard a ship when steaming against foul winds? What was the cost in wear and tear, and interest, of the sail power? Lastly, this ship had ·3 of light foul winds to ·7 of strong fair winds, suppose we allow ·1 for the difference of force, and say that she had ·2 foul to ·8 fair winds; and suppose we strike a proportion, allowing that a ship must expect as much foul as fair wind, what shall we get as the result? To answer the last question, and the rest with it, we get her average gross saving at no more that 37 per cent. from which we must deduct the loss due to foul winds acting on masts and yards, and the gain due to fair winds acting on a mastless hull, as well as the probable saving due to the reduced speed. When I followed this gun-vessel to conditions where fairer averages may be taken, I got a gross saving of coal, without any *per contras* whatever, such as I have noted above, *of 5 per cent. only*. In this case the struggle to make a steamer a sailing ship, or a sailing ship a steamer, whichever way it may be looked at, has resulted in a ship very helpless indeed under all circumstances requiring propulsive power. Space does not permit me to go more into this question at present, I have brought this forward to throw the *onus probandi* on those who differ from me.

37. So far, I have got at two conclusions, our war ships must offer defence at sea, and they must have each a coal supply equal to 4,000 miles steaming at five knots, while their sail power is to be reduced to a pure auxiliary. I have now to consider how ships may be made most capable of offering this defence at sea, and I shall best do this by considering something of the classification of war ships. In the first instance; what induces classification at all, and what classification is best suited to British requirements? There always have been classes of ships, for the simple reason that it would have been uneconomical to have built but a single class. In the great naval epochs of the past, the classification was almost rigid. The line-of-battle ship, the frigate, and the sloop, formed the three great divisions into which all navies were then classed. The more technical "rate" then, as now, subdivided all classes of ships above the sloop, but the "rate," though it meant more than it now does, was not so complete a classifier as the terms used above. To-day the classification has very much broken down. We have the ironclad, the frigate, the corvette, the gun-vessel, and the gun-boat, as the nucleï of a possible classification; but "classification" as a part of a settled naval policy does not exist. One of the most prominent results of the older classification was an agreement among nations that each class of ship was designed to fight her fellows; one of the results of the present, perhaps unavoidable, want of classification, is that there is an idea that any ship should be ready to attack any other. Purely naval opinion is clear enough, that the old system was right; but public writers of power and influence are not wanting to say that naval opinion, in this instance, is wrong. Yet nothing has occurred as yet to shake the lesson of history on this point, and naval opinion is so far right to rest upon it. The economical results of a happy classification will be admitted on all hands; but those who have been in power have feared that with our present knowledge of the new naval forces and weapons daily growing up, any classification is as likely to be *unhappy* as to be happy. France is quoted against a classification, but I think when she produced many ironclads—or earlier, when she produced many paddle steam-frigates—of a particular type, she got a good economical result for the time, and the ships she built with an eye to classification are not more obsolete than those which we build without any eye to classification. Names will help us much on a matter of this kind, and so far as I can see, we should do well to adopt a simple nomenclature which would have the double effect of steadying our view, and of giving us an easy way of speaking of war ships. The term "ironclad" is after all a fallacious one, as there is as yet no settled system of placing the armour, nor any regulated allowance of its thickness or quantity. But all ironclads, whether large or small, whether with much or with little plating, are now expected to fight all other ironclads, whether success be probable or no. Most ironclads will assemble in fleets, as they do at this moment, and I should propose to call that class of ship which represents the old line-of-battle ship in this matter—a "fleet-"ship." Then I see no reason why the next class should not retain the name of "frigate," the next "corvette," the next "sloop," and the

last "gun-boat." "Sloop" is a fine old name, without at present any home, I do not see why it should not take in all Her Majesty's Ships commanded by commanders, and find a home there. I suppose there will still be "dispatch vessels," "torpedo-boats," rams, &c., but these in my view are temporary and insignificant, and I leave them out of my scheme. Under these five classes I should range, as best I could, the existing Royal Navy, and all future ships should be designed to more and more nearly approach the ideal uniformity typified by the classification adopted. Before I go farther, I should point out that the "gun-boat" will be practically left out of my general scheme. Such vessels are more weapons of attack than of defence, they are quickly built and would always be prepared with reference to special localities and particular duties. The few employed in peace time have fields of operation in guarding those very minute commercial rivulets which flow up shallow waters in various parts of the world; and in war time their defensive powers would still be similarly engaged; they would never be expected to patrol the greater channels of commercial intercourse.

38. Taking first therefore the "Fleet-Ship," I am prepared to say that she should be a broadside ironclad of moderate dimensions, of moderate gun-power, and with a moderate thickness of armour. I say this with a full knowledge of all the shafts levelled at such ships, and in full view of the modern gun, the ram, and the three classes of torpedo; and I am prepared, I think, to show that "power and "economy" to use the excellent words of the Council, are not to be got for the fleet-ship, but out of this type. The touchstone of the whole matter is to be found in this combination of economy with power; because, as a moment's reflection shows, uneconomical power is not power in the true sense of the word. In approaching the question, a fixed sum of money must be assumed to be spent in a given time. The most powerful single ship which can be produced for this sum of money is not necessarily the most powerful naval force which the money can command. It is only so if the same money will produce nothing capable of matching her except a sister vessel. Nor would it be economical to produce such a single ship if she were so vastly superior to every other, that nothing could face her singly. The question would arise, whether she could be where she was wanted at the time she was wanted, or whether two or more ships could not be built which—only costing a like sum—would be as much superior to her when combined, as she was to any former single ship. The drift of this argument is in part perceived by those numerous writers who assert the demise of armour-plating, and who see in the Chinese "Gamma"—and "Delta," the answer to the "Inflexible."[1] They are quite right so far as they go, but they do not carry their argument sufficiently far. The "Inflexible" was an answer to the Italian "Dandolo," but was not an economical answer. If the "Inflexible" mounts only four 80-ton guns at a cost of £500,000, and if the "Gamma" mounts a 38-ton gun which she can fight at sea, at a cost

[1] *Vide* Mr. Brassey, in the "Times" of 30th May, 1877.

of only £25,000, it is pretty certain that so far as gun-power is concerned, the "Inflexible" is neither powerful nor economical. But then if this is admitted, we cannot stop with the writers alluded to, at the "Gamma" as the type of future gun-ship. The "Gamma's" fire from her one gun is slow, and not more certain than that of much smaller guns. If all nations now took to building "Gammas," it would very soon be discovered that the occupation of the 38-ton gun, as well as of all heavier, and some lighter types, was gone! No one in his sober senses would build and arm a "Gamma" to fight another "Gamma," or if he had already committed himself to the ship, he would speedily alter her armament, and substitute several lighter guns for the single heavy one carried by his opponent. Thus the "Dandolo" destroys herself and her guns together, by producing the "Gamma,"—a statement which, to many persons, will appear to say that we are in a vicious, circular style of argument in the matter of guns and armour. I, however, am assured that the "Dandolo" with her 100-ton guns and her heavy plating, forms one extreme, and the "Gamma" the other, of a system of experimental argument, which will bring us all to a happy mean between them. When you have a ship which, costing a certain sum, is able to successfully defend herself against two or more ships costing together the same sum, all by the use of guns and armour, then, so far as guns and armour alone are concerned, that type is permament. If the "Inflexible" or "Dandolo" could reply, gun for gun, to the number of "Gammas" which could be built for £500,000, it would not be so easy to condemn her as opposed to a fleet of the latter class. It is because she can only reply to at best a very few of them, that she shows as an uneconomical power.

39. To regard this question in its true light, it must be remembered that against guns there are two kinds of defence—*resistance*, offered by armour, and *avoidance*, offered by a small target. The "Inflexible" is the extreme representative of the former; and the "Gamma" of the latter. If defence by resistance is offered, the attack can only meet it by increasing the weight and space occupied by the guns; as both of these are limited afloat, the numbers of guns carried by the attack, are limited and controlled by the strength of armour offered in defence. Armour-plating has in my opinion no other function than this. Invulnerability can never, I think, be attained. If, however, defence by avoidance is offered, then the attack reduces the size of its guns, in order to increase their number. It would be paradoxical to assert it as a fact, but it is well to contemplate the possibility of very heavy armour, combined with only numerous light guns in a single ship. It is quite true that such a ship would be comparatively inoffensive when attacking an ironclad, but what would the ironclad do with her guns which only just pierced under very favourable conditions; and what again would the ideal unarmoured ship with only a few guns do against the other's many? But passing this by, we see that by carrying armour you compel your enemy to take few shots at you in any given time; while if you carry a greater number of effective guns than he does, you compel him either to increase his armour so as to reduce

the number of your guns, or else compel him to abandon armour altogether. He can, as we have seen, only do this, by a more or less near approach to the "Gamma" idea, and if it is more costly to put afloat in "Gammas" a number of guns equal to those lighter ones with which you are prepared to meet them, your guns being numerous, then he has no resource except to build, armour, and arm, a ship of the same type as yours, and so fight it out with similar weapons on equal terms. This is the argument as regards guns and armour, and to me it is as clear as daylight, that on these grounds the heavy gun will remain, and that the ironclad will remain, but I doubt about the very heavy gun, and the very heavy armour. I do not think that there is as yet anything in the ram or torpedo to alter this prediction. It is impossible on the data available outside the Admiralty, to say exactly whereabouts this medium between the "Inflexible" and the "Gamma" will lie, but as it is necessary for me to assume a medium in terms of English armour and guns, I take it at the 18 to 25-ton gun, and from 10 to 12 inches of the present armour-plating. As to the latter, I must express a firm conviction of very old standing, that practically little has been done in the matter of armour for ships. I think that by the use of steel, of chilled iron, or by discoveries in the distribution of armour, or of all combined, its resisting power for a given weight will be probably much increased, whereas I do not see that the effective power of the gun is capable of very material increase irrespective of increased size and weight. The only point I make in the above selection is a security that my fleet-ship cannot be successfully attacked by guns of less power than the English 18-ton gun, and that this gun to be effective must engage her at less than 800 yards. These are moderate desires, and quite within our compass, and I suspect that such ships cannot be economically and successfully attacked with guns except by ships of like nature; but this will better appear later on. For the fleet-ship we have thus got four of her chief elements: namely, (1) a coal-carrying capacity equal to 4,000 miles at 5 knots; (2) a rig absolutely auxiliary; (3) 18-ton to 25-ton guns; and (4) 10-inch to 12-inch armour. If it is at this stage alleged against me that a single "Dandolo" coming amongst my fleet of moderately strong ironclads must put them to flight, as her armour is impervious to their guns, then I answer that to float a "Dandolo" my enemies must have long time and preparation; I will suspend the building of one or more of my fleet-ships when the time comes, in order to build at a less cost than that of the "Dandolo," and in a much shorter time, a sufficient number of "Gammas" to master her. This is setting aside what I might do with my moderate ironclads themselves in the way of rams and torpedoes.

40. In every class of war ship, I think a great principle should as far as possible govern construction. This is the principle of *duality;* everything should when possible be doubled, in order that the disorganization or destruction of one part, should still leave the fellow of it efficient and ready. No single chance shot, chance blow, chance accident, ought to utterly paralyze the ship; she should, to the fullest

possible extent, be provided with a second item to fall back upon should the first be destroyed. Thus, for the fleet-ship, she should be double below water—a ship within a ship—in order to allow her outer skin to be pierced without admitting water to the ship proper. In her compartments they should be so arranged that no two of them would sink her when filled. Her engines should be double, with a double set of boilers—each engine being capable of connection or disconnection with each set of boilers, or with all, or any of them. The two sets of boilers should be in a separate compartment, and if possible, one compartment should be before, and one abaft the engines. The engines themselves should be each in a separate compartment. The screws would of course be twin, and, I think, might well have gearing connecting each with the other when desired, so that one engine could work both in case of the other being disabled. But the greatest application of the dual principle should be in the gun armament of the fleet-ship. This should be double: a heavy armament to meet armour, and a light one to meet "Gammas," torpedo vessels, and all other unarmoured ships. The heavy battery should be divided into two, so that a great disaster in one half battery will not affect the other. I should carry this duality to very great lengths in the larger ships. There should be two steam fire engines, each to do the duty of bilge-pumps and capstan engines, and the two capstans should be capable when manned, of taking the place of the steam fire engines. The whole, and half the pumping power should be capable of acting on any single compartment, and a double set of pipes would make the danger of accident twice as remote. In the smaller classes of ships the dual principle could not be carried so far, but I suspect it might go farther than we think for.

41. When sketching out the great principles which should govern construction in an ideal English Navy as a defensive force, I have to remember that it is to repel the gun, the ram, or the torpedo with success, and it is time that I should write the general principles I propose to adopt for these purposes. I have already mentioned the two species of defence against guns, namely, *resistance* and *avoidance*, and these also avail us against rams and torpedoes, though not perhaps to a like extent as against guns. I think each species of defence should be employed in every case. As against the gun, I propose to use armour for resistance, and to reduce the size of the vital target to the smallest limits. I am strongly disposed to think that I would not confine armour to the fleet-ship, but would employ it to a limited extent in the frigate. In the placing of this armour, I should follow a dictum on which we are all pretty well agreed now, although the principle does not appear in all past types of ironclads, namely, that the ship should be protected first, and then the guns—or rather, and then the men. As proper systems of compartments do in fact offer great protection to the ship, it does not necessarily follow that all, or even the greater part of the armour should offer no protection to the guns; on the contrary, I think it is only where compartments are absent that guns should be without resisting protection, and I can conceive a cellular hull without armour, carrying an armoured battery of

guns, with much prospect of success in action. But the fleet-ship, and perhaps the frigate, would in my scheme have their water lines, and their batteries both protected by armour, but its disposition will differ from any which has to my knowledge been as yet proposed. For the defence against rams, I offer in the first place the avoidance by manœuvring, but I am not prepared to incommode my coal stowage already fixed on, by any shortening of the ship for manœuvring purposes. I am quite ready to condemn excessive length for the attainment of excessive speed, but I must have my 4,000 miles of steaming power whatever be the consequence in length. I am strongly disposed to think, however, that a ship may often avoid a fatal crushing in her side by opposing resistance to it. With plating arranged as in the "Devastation" target of May, 1871, in two thicknesses, it is possible to back the butts of two plates by the centre of a third; if this vertical structure is again backed by a horizontal angle-iron or feather such as an iron deck represents, it would have great resisting power, and with an inner skin behind it might be successful against a ram. But if the great principle of duality, as applied to compartments, be adopted, I do not see how a single ram is to inflict fatal injury, and I would risk it. For defence against the torpedo, I rely very much on avoidance. The course of investigation into the torpedo question has not been, so far as public knowledge goes, to raise that weapon in naval esteem. As a harbour defence I have for the present nothing to say to it, but as a sea attack, with which I am now alone concerned, the Whitehead is the only species which is seriously feared. Reasoning from analogy, I should think it fair to suppose that the fear of the weapon will not increase as it becomes familiar to the Navy, and as those weaknesses which exist in every new invention are brought into view. But when all this is said, the weapon cannot be ignored, and the only defence of resistance that I know of is a proper system of compartments. If a ship is prepared to stand one exploding Whitehead without sinking, I suppose her to have used her defence by resistance to the utmost, and this she may attain by taking care that no two compartments when filled will sink her.

42. Thus far, for the purely defensive arrangements of a purely defensive British Fleet. But a defensive fleet is not necessarily inoffensive, on the contrary, much of its defence must rely on the fear of its enemies to attack. With what weapons is the fear to be established, and how are these weapons to be disposed? I have already committed myself to the gun, up to the moderate weight of 25 tons, and I have already claimed its disposition on this broadside as the best. To me it is an astonishing question which is commonly put—"whether "is the bow or the broadside the most important fire?" because I have never heard a serious argument in favour of the bow fire. I know that an opinion in its favour exists, or is supposed to exist, because in a great many ships, the broadside is weakened, and very many terrible inconveniences, and dangers, submitted to in order to supply bow fire. But I have only heard it asserted in support of this policy, that as a ship must not expose herself to be rammed, she must be prepared to fight an end-on battle. But unless she is pretty close to her enemy,

and in a particular relative position, there is no objection in life to her presenting her broadside, and an end-on battle must become a broadside one after the lapse of a very few minutes. But here again, the question is one of fact, not opinion. It is certain, because a ship is longer than she is broad, that the broadside fire can always be made more powerful than the bow fire. It is also certain that the vertical target presented by a ship end-on is less than that presented by a ship broadside-on. I have examined the firing of some of our ships provided with bow fire, and find that bow guns of an average ship throw away 26 per cent. of their fire, under conditions when the broadside guns of the same ship only throw away 16 per cent. of their fire. But the idea of bow and stern fire has not grown up, as we generally suppose, on reasoned ground; we have been drawn into it by an historical process. Bow and stern chasers were in old days, and may be now, regarded as useful adjuncts to a ship's armament, and therefore there was always that idea to rest upon. The paddle-wheel occupying the space required for broadside guns, drove them to the bow and stern. As there was little space there, an increase in the power of the "pivot-guns" was sought as a substitute for their necessary reduction in number. Screw ships found the pivot-gun already established, and adopted it as their long-range weapon of attack. The naval mind was thus familiarized with the idea of "all "round fire." The two merits of the turret ship as originally proposed, were its entirely armoured condition, and its "all round fire." There was a tendency to show that other arrangements besides the turret could develop "all round fire,"—so we got ships with guns placed ill for broadside fire, but well for bow or stern fire. And having such guns, controversy arose as to their relative values. It was never seen that to make all round fire important was the natural aim of those who supported the turret system, but that it was, with the screw ship in motion, and especially with the twin-screw ship, a matter of less vital importance. When it was as easy to turn the ship as the turret, why lay such stress upon the arc of training? In the result, the great merit of all round fire was given up, and the supporters of turrets—having already given up complete plating—claimed for turrets—a claim they still support—the power of mounting heavier ordnance than any other system. But meantime we had got the special end-on, and the special broadside fire into a good many ships—the real history of birth was forgotten—and ancestors were found for each kind of fire in questions of tactics which were practically younger than the ships themselves. On such grounds I throw over without fear the "end-on" fire; I decline to weaken the broadside for an advantage so problematical, and I prefer to be very strong in the directions where my strength would most naturally develop itself, to making myself everywhere weak. I am certain that my enemy must either fly, or let me get my broadside to bear on him, but I do not know any means of making him fight an end-on action if he does not choose to do so. I have, however, no objection to a light end-on fire as an adjunct to the heavy broadside fire; and I think that if the foremost and after guns of my heavy broadside

battery can bear a little more forward and after training than the others, it will not be amiss, provided it does not detract from the ordinary broadside power. Such is my present faith as to guns. As to the ram, I hardly know any class of ship to which I would not fit it. I am not so anxious for a "spur" proper, but I think that every class of ship ought to be able to ram her fellow without too much damage to herself, on any convenient opportunity. I am not so well disposed towards the torpedo. I think that it is not impossible a towing torpedo may be constructed worthy of a place in the armament of a defensive fleet-ship, but I have no belief whatever in the Harvey as a defensive weapon, and I exclude it without hesitation from my scheme. I have much more faith in the "outrigger," but as I hinted in the early pages of this paper, it appears to be the proper weapon of a blockaded, not of a blockading or patrolling force. There remains the locomotive torpedo, of which the Whitehead is the most celebrated illustration. If I leave this weapon out of my scheme, I must not be understood as rejecting it, but it is too young, too little known and too untried to take a place in a scheme which boasts of being founded on fact.

43. I think that I have thus far marshalled and discussed all the great principles which should govern construction, and it now behoves me to show their practical application to the classes of ships I have suggested as proper for our Navy. I shall here give no more than an outline, because the explanation of several completed designs would be foreign to the purpose I assume to be held in view by the Council of the Institution. I do not suppose that all specimens of each class will ever be identical in all respects, but I consider that they should be as nearly so as the gradual development of improvement allows. I think there would probably be two divisions of the fleet-ship class, the smaller for the more distant services, and the latter for blockade, and fleet work nearer home. I should put the displacement of these ships at 8,000 and 6,000 tons respectively, and probably the one might be called on to mount 25-ton guns, and the other 18-ton guns. The frigate would displace about 4,000 tons; the corvette 2,000 tons; and the sloop from 600 to 1,000 tons. I shall now proceed to describe a second class fleet-ship according to my design, and in doing so will compare her with an existing type of her own displacement. Such a comparison is necessary to fix our ideas and to show the advantages gained by adhering to the principles I propose. The first class fleet-ship would be of the same type, but larger in every way; while the frigate would in many respects be a smaller fleet-ship. The corvette and the sloop would differ in arrangement, but there would be between them a more complete symmetry than exists just now.

44. The existing type of ship which I have selected as my exemplar is the "Invincible" class: of which the displacement is 6,034 tons; the I.H.P. say 4,500; the heavy armament ten 12-ton guns; the light armament insignificant; the armour 8 inches thick to protect the vital water-line and not exceeding 6 inches elsewhere. The compartment arrangements are such that the two largest communicate by a supposed watertight door below water, and are together amply

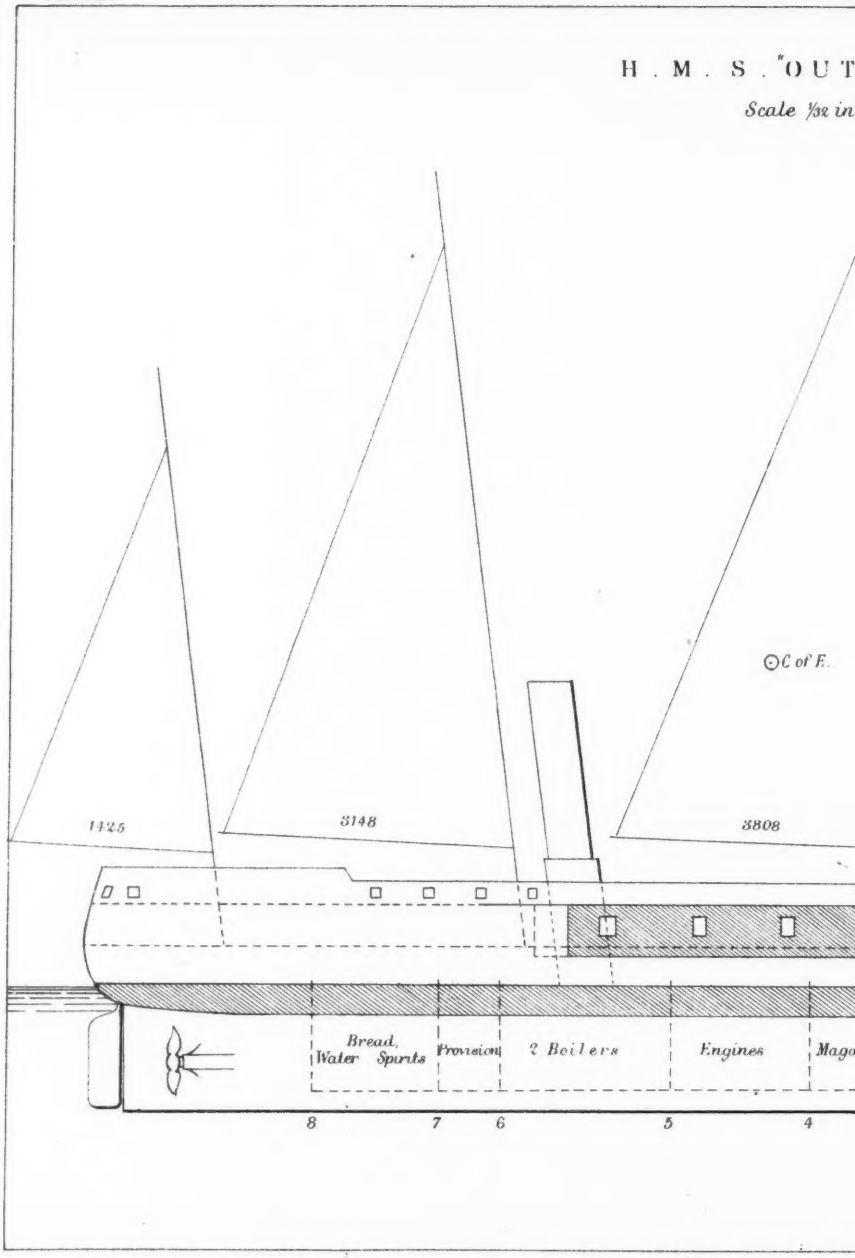
sufficient to sink the ship when full. The inner skin does not reach the water-line, nor even the deck below the water-line, so that a leak below the water-line lets the water directly into the body of the ship. The class carries some 460 tons of coal, 160 tons of masts and sails. The weight of the hull, including armour and backing, is 4,000 tons, and of the armour itself 900 tons. The plating extends 5 feet below the water-line, and to about 4 feet above it. It is connected by armour to that of the main battery, which carries six 12-ton guns, mounted as broadside guns, in the usual ports, and above this main battery is a central armoured upper battery, the guns in which are mounted to train from a fore and aft position to one exactly abeam. The class is rather deficient in boiler power; and of course very deficient in coal stowage; at five miles to the ton, which is probably their average steaming power at five knots in smooth water, the class has no more than 2,300 miles in their bunkers. Their area of plain sail is about 24,000 square feet, or about 4 square feet per ton of displacement; and to enable the "Invincible" to carry this sail, she has 360 tons of ballast, otherwise useless, and a drag upon her.

45. The "Invincible" is thus, to my view, a second class fleet-ship. She has been designed to resist the attack of every gun of less power than our own 6½-ton 7-inch gun, which penetrates 6-inch plating at 400 yards. It is part of the design that a fatal wound cannot be given at the water-line, by a gun of less power than the 12-ton. Some advantage has however been allowed to the compartmental arrangement, as a protection from the fatal effects of shot. As to the attacking powers of the design, immense, and to my view, undue advantage had been credited to fore and aft fire, and very great sacrifices have been made to protect the fore and aft guns by armour. In the first place, the area of side armour covering the main battery is 247 square feet per gun; therefore to mount five guns on the broadside would cost 1,235 feet of armour, or 2,470 feet for the double broadside; add to this the ends at 1,150 square feet, and we get 3,620 square feet as necessary to mount ten 12-ton guns in a single broadside battery. But to mount these guns as in the "Invincible," six on the broadside, and four fore and aft, costs 4,445 square feet, or 825 feet more: or, taking the armour at 6 inches with 10 inches of backing, a weight of 102 tons. Besides the actual weight thus lost, the height of the upper battery induces weight by carrying the gunwale up to it; and its moment above the centre of gravity has much to say to the necessity of ballast. The question therefore remains for those to answer who advocate the protected fore and aft fire, "Are you prepared to spend 100 tons of "weight on it, when the whole of your heavy armament costs you "but 300 tons? Is it better to increase your heavy armament by "one-third, or to spend the weight in placing some of your guns so "as to fire in a line with the keel?" In designing the propulsion of the "Invincible," the conclusion has been that coal supply is less important than sail power, and practically it is seen that it has been considered wise to spend 526 tons of weight on the development of sail power. I say nothing of the actual performances of the class under sail, for it may be an accident if they are not proficient in that respect.

46. Now, it may be observed that in the case of a second class fleet-ship of 6,000 tons, I am prepared to advise a certain trusting to the compartmental system for the protection of the ship; that I do not think it is wise to spend 100 tons of weight on obtaining a protected fore and aft fire; and that I do not think it is wise to spend anything at all approaching 526 tons on the development of sail power.

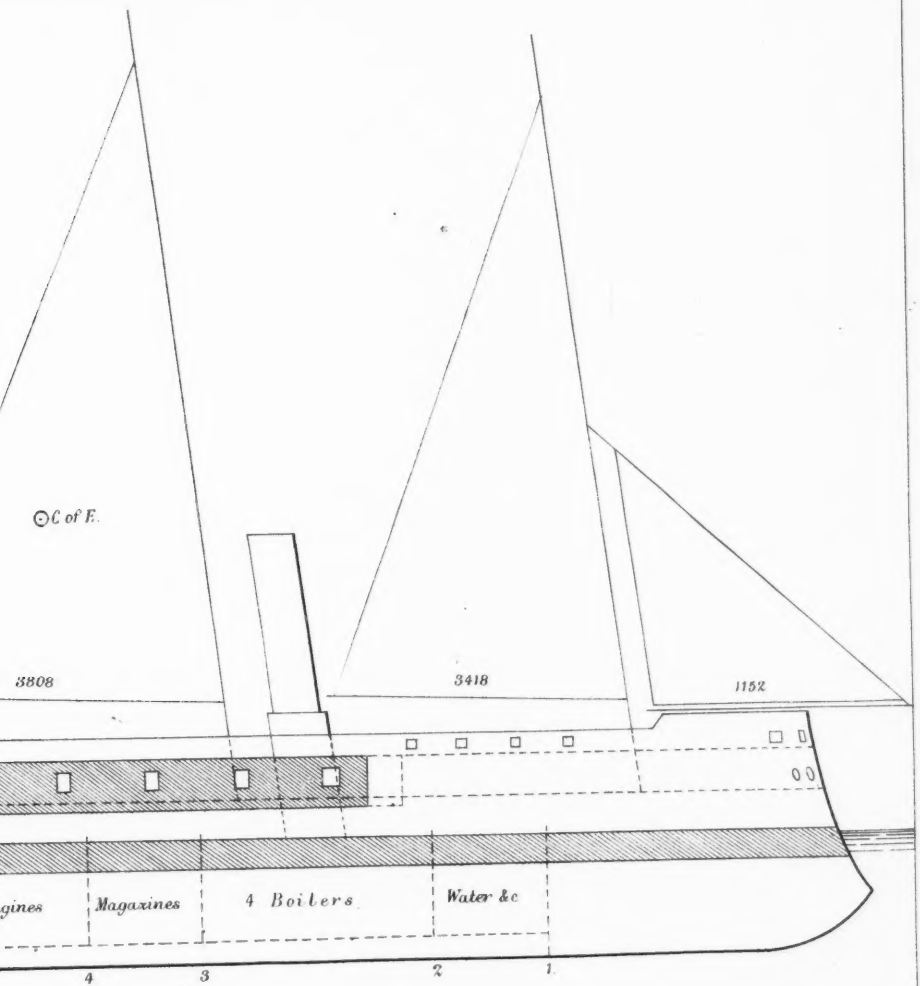
47. I propose, in placing my views in the concrete, to take the lines of the "Invincible" below water as a fixed standard to work upon, and I propose very little alteration in her outward form above water, and practically none in her construction. In this way every proposed alteration will have a measure, or standard of comparison, and the rough outlines of my design may be criticised by an appeal to existing facts. It is necessary for me to state that as I have only collected the main points of the "Invincible's" design here and there, and by calculation and inference therefrom, my figures must in no case be thought rigidly accurate. In a paper of this kind, I have thought that a reasonable accuracy is all that is required. Turning now to Plate II, we have before us the profile or elevation of my design for a second class fleet-ship to supply the place, say of the lost "Vanguard." In the design, the bow and stern above water are both thrown in a little to make up for the placing of certain weights on the extremes of the upper deck, which are not present in the "Invincible." A light poop coming forward 47 feet is added, as a set off against the removal of the deck above the "Invincible's" upper battery. The whole of the gunwale fore and aft is lowered 2 feet, and the removal of this weight may be taken as margin to cover deficiencies; otherwise the exterior of the "Invincible's" hull is practically unaltered. In the "Invincible" the lower deck is 2 feet 6 inches below the water-line, and in the "Outrageous" this deck is carried up 3 feet, to 6 inches above the water-line. Below this deck the "Outrageous" is divided into nine main watertight compartments. The distance from No. 1 to No. 8 bulkhead is the same as in the "Invincible," but between these there are in the "Invincible" but four main compartments—compartments, that is, with bulkheads carried up to or above the water-line. In the "Outrageous" there are at least seven. In both "Invincible" and "Outrageous," the double bottom extends from No. 1 to No. 8 bulkhead; in "Outrageous" this double bottom is carried up to the lower deck; in the "Invincible" it stops short 5 feet below the water-line, but in the "Invincible" it is 4 feet 10 inches wide at that point, whereas in the "Outrageous" it nowhere exceeds 3 feet 6 inches. The main deck of the "Outrageous" is 7 feet 10 inches above the lower deck, which gives a height of 6 feet 6 inches below the beams on the lower deck before and abaft the battery, and of 5 feet 8 inches under the battery itself. The main deck is 7 feet 7 inches from deck to upper-deck, or 6 feet 6 inches under the beams.

This may be thought low for the 18-ton guns I propose to put in the battery, but I see no reason why the axes of the guns should not be brought down in mounting, and 6 feet 6 inches will allow 10° elevation and 10° depression even to the 35-ton gun. It is most important to reduce the area of plating, and the consequent exposure


H . M . S . "OUT
Scale 1/32 in
⊙C of E.
1425
3148
3808
Bread, Water
Spirits
Provision
2 Boilers
Engines
Maga
8
7
6
5
4

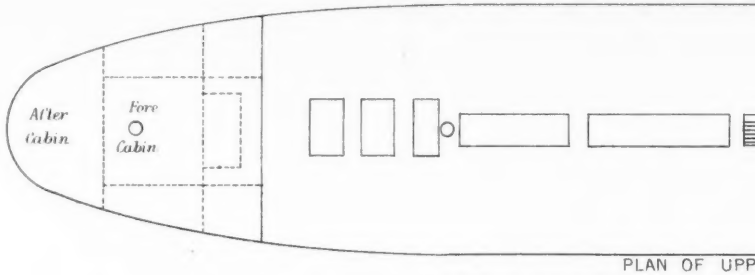
. "OUTRAGEOUS"

Scale ⅛ in to 1 Foot

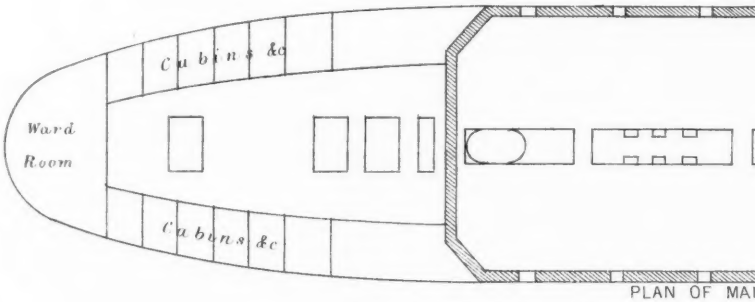


J. Jobbins

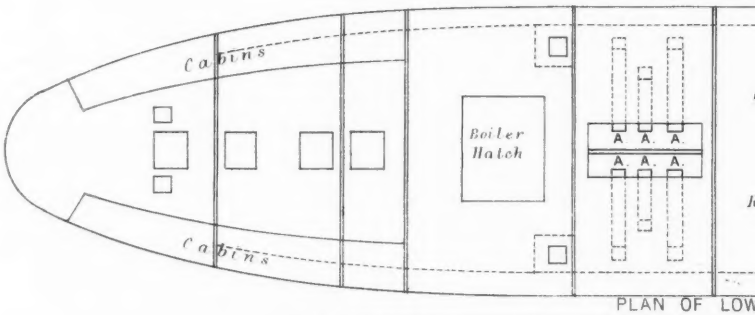
H . M . S . OUTRAG



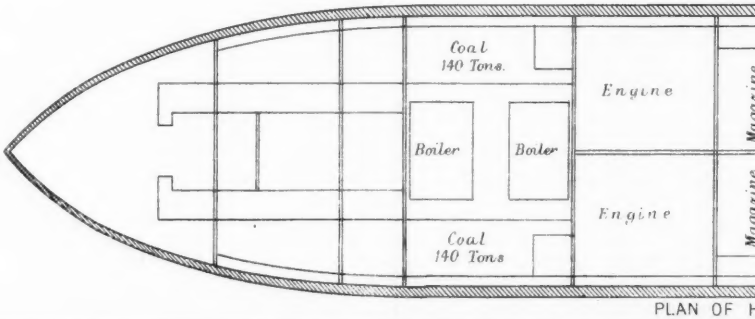
PLAN OF UPP



PLAN OF MA

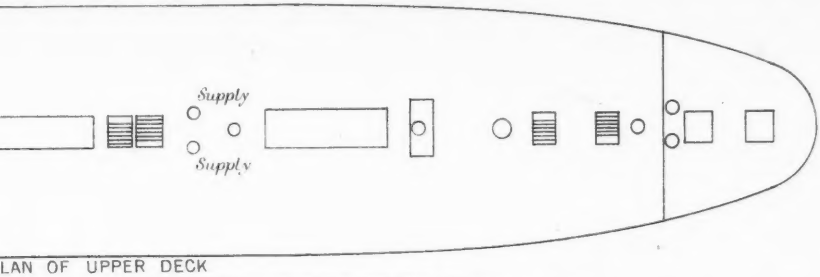


PLAN OF LOW

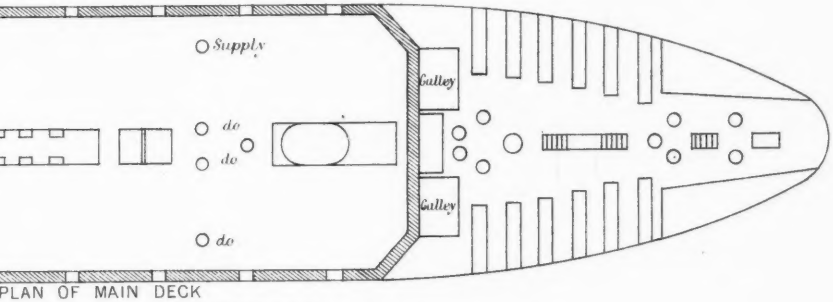


PLAN OF H

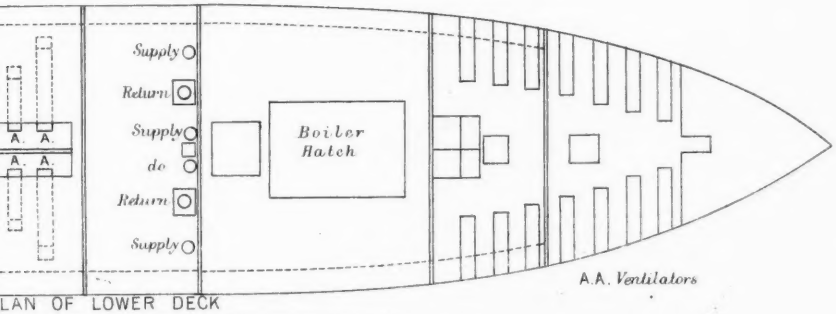
U T R A G E O U S *Scale ½ in to 1 Foot.*



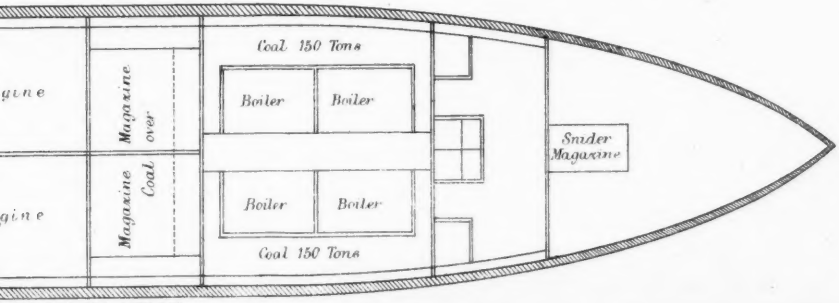
LAN OF UPPER DECK



PLAN OF MAIN DECK



LAN OF LOWER DECK



PLAN OF HOLDS.

J. Jobbins

of the men under it. The upper deck gunwale is 4 feet 6 inches high, representing a parapet to admit of rifle fire over it. As compared with the "Invincible" the main deck of "Outrageous" is 2 feet 7 inches higher above water than her main battery deck, and the centre of midship port of "Outrageous" is 11 feet 2 inches above the water-line, while that of "Invincible" is 9 feet 10 inches. The upper deck of "Outrageous" is thus raised above water 7 inches more than that of "Invincible," and this statement concludes all that is necessary to say on the general structure of the proposed ship. I may say here that in proposing these changes, I am not forgetting either weights or moments, but as to the former, the simple raising of the decks does not increase them, and additional bulkheads, &c., are made up for by the removal of others.

48. I come now to my arrangements below water, and my explanations will refer to Plate III as well as to Plate II. The ends before and abaft the main compartments may very well stand as they are; the usual arrangement of sub-divisional compartments properly tight, and without the treacherous but common sluice valves, ought to make the ends reasonably secure, so far as they go. The first compartment counting from forward in both ships would contain water, hemp cables, &c., and perhaps chain cables; though in "Outrageous" I might possibly stow them elsewhere with advantage. In the second compartment are 4 boilers and 20 furnaces, two-thirds of the whole boiler power of the ship. In the "Invincible" the whole boiler power is in this compartment, and this traverses the great "dual principle" to which I have committed myself. This compartment in "Outrageous" likewise contains in round numbers, 300 tons of coal stowed at the backs and ends of the boilers. The third compartment contains the magazines, which occupy the whole of the compartment in a fore and aft direction, and to within 4 feet of the inner skin transversely. The crown is the same distance below water as that of "Invincible." Coal is stowed *as a reserve* above the crown of the magazines, and in the wing spaces. The magazines are two in number, divided by a fore and aft bulkhead, each has three passages, which are lighted through No. 4 bulkhead from the engine room. The handing rooms are on the fore side, and each has two supply scuttles, and one return. The supply is protected from the lower to the main deck by a wrought iron cylinder 3 inches thick, so that bursting shell, or light shot, shall in no way interfere with it; and as the supply is direct to the battery, much less labour is involved in it. Passing to the fourth compartment we come to the engines, which I assume would be compound in the new ship. In the "Invincible" the engines are together, but in the "Outrageous" I propose to separate them by a fore and aft water-tight bulkhead—still following out my principles. Abaft the engines is No. 5 compartment, which contains two boilers, each of five furnaces, placed athwartships between the shafts, with 140 tons of coal stowed behind them in each wing. In the "Invincible" this compartment takes the engines, but I prefer, as I have said, to have some boiler power abaft, as well as before the engines, so that there shall be a double system of communication between the engines and their prime

mover. But now, as the space at my disposal for engines, magazines, and boilers, from No. 2 to No. 6 bulkheads, is exactly the same in "Invincible" and "Outrageous," it may well be asked how I am able to put into it boiler powder to 30 furnaces against the "Invincible's" 26; coal to very much over 600 tons, against the "Invincible's" 460, and powder to the extent of 56 tons, against 30 carried by the "Invincible?" The answer is simple enough.

I have rid my ship of light rooms, of a wasted passage, and of a shell room, and beside this the compartments are everywhere higher. As to the shell room: so soon as it was admitted that shell may be carried in the open, there was an end to shell rooms, and I have properly left the whole of the shell to be stowed as convenience dictates. The after compartments, as in the case of those forward already spoken of, might remain as in "Invincible" for the stowage of water and provisions. Ascending now from the holds to the lower deck, the observer would find it clear fore and aft, except as to cabins extending along each side. Unlike the "Invincible," there are no watertight bulkheads with assumed watertight doors, and the deck is comparatively lofty, except under the battery. But though there are no bulkheads, a reserve of buoyancy is got in a much more really secure way. The main bulkheads are prolonged for 2 feet above the deck, so that water cannot flow freely beyond them. As to convenience, these are readily stepped over; and as to safety, no errors or neglect of those on board can mar their good effects in time of trial. I may here observe that I have always thoroughly distrusted appliances such as watertight doors, sluice valves, &c., which require for their efficiency care and thoughtfulness. When nothing else can be had, then of course we must do the best we can with them, but in my experience I have never seen them *absolutely* necessary. But there is another novel arrangement about the "Outrageous'" lower deck, which must be mentioned before we go further, and which points the moral to the foregoing observations. Hatchways leading to holds are now left usually open. I propose to fit them with sliding doors, to become airtight by upward pressure, as well as watertight by the usual clamps or screws. I am not aware that such a defence against torpedoes has yet been thought of, but it is very certain that if the air cannot escape out of a hold, or compartment, *very much* water cannot enter below. So far, I have kept to my principles; we have here a ship with two sets of engines, two separate sets of boilers, and two magazines. These are all enclosed in separate compartments, and no two of them, if filled, will absolutely sink the ship. In doing this we have not sacrificed much. The engineer cannot pass to his boilers without ascending above the water-line, nor can he pass from engine to engine except in the same way, but practically this is the whole of the trouble involved, and we can easily reconcile him to his fate by convenient voice pipes (always carried *above* and not *through* the bulkheads). Having thus secured all reasonable protection by means of bulkheads, we have to recollect that unless something is done to prevent it, the lightest shot may enter between wind and water, and may easily fill more than two compartments in an ordinary action.

The armour belt is thus to my mind a necessity of the day; but whereas the "Invincible" carries a belt extending (I gather) from 5 feet below the water-line, to 4 feet above it, I propose to cut off the upper 3 feet 6 inches of that belt, and let it extend from 5 feet below the water-line, to 6 inches above it. I am going to do this because I intend utilizing a fact which there has been great trouble to get at, but which by the researches of Mr. Froud, and the practical experience of Mr. Reed and Mr. Barnaby, has been brought out for use. The "Invincible" class does not roll. One of these ships may pass through a commission and never heel or roll more than one or two degrees. What does this imply as to the matter in hand? It tells us that a deck somewhere near the water-line cannot be struck by the shot—except the very distant shot—of another ship, at any considerable angle. The "Invincible" herself for instance with her upper battery guns depressed to even 10°, must get her enemy's water-line deck within 95 feet of her to strike it at that angle. If the deck is below water, of course she has so much the better chance, inasmuch as her shot penetrates above water and goes down afterwards. But what chance is there of getting a shot through even a lightly armoured deck, which cannot be struck at a greater angle than 10°, and that only when within 100 feet of the enemy? Most shot will in point of fact strike a water-line deck at no greater angle than one or two degrees. Even at 5°, a half-inch plate must have nearly the resisting force of a 6-inch plate struck at right angles, and in this view the $\frac{5}{8}$-inch iron which now covers the lower deck of the "Invincible" would be to her if the deck were brought up to the water-line, nearly as complete a protection as her present 6-inch vertical armour. On these grounds, I propose, I think reasonably, to take away a large slice of the vertical armour above water, and to clap it on in extra thickness from 5 feet below the water-line, to 6 inches above it, also in horizontal plating, and otherwise as will appear in due course. How much I am going to gain by the process may be briefly stated; taking the armour belt of "Invincible" as 5,292 square feet in area, the new area in "Outrageous" will be only 3,234 square feet, giving me a difference of 2,058 feet, which at an average of 5·3 inches of plate, and 10 inches of backing, is perhaps good for 229 tons. We may now pass to the main battery, about which little need be said at this moment. It is constructed in the usual way, and of the usual shape, and the only difference in principle between it and the main battery of the "Invincible," is the greater size of the foremost and after ports on each side. I have already advocated increased arc of fire for the guns in these ports, and I know no simpler way of giving it than by increasing the size of the ports on the fore-side of the foremost guns, and on the after-side of the after guns. I assume in settling the height of this battery deck at 6 feet 6 inches below the beams, that the guns can be so mounted as to fit that height, and the portsills can of course be lowered to suit the axes of the guns, as they are by the hypothesis, 1 ft. 4 in. above those of the "Invincible." I do not propose to have any doors in the transverse bulkheads of the battery; it is well to have those bulkheads as secure as may be, and the

convenience of an entry to the battery on its own level does not weigh a feather against the extra security of solid bulkheads. In one point I abandon my theory. I propose a single battery in this type, whereas did I carry out my views to their conclusions, I should divide it into two by a transverse bulkhead. The only reason I do not do so here is because it would interfere with my argument and mar its clearness. Were I designing a ship which was to be put afloat, I should make the sacrifices necessary to get this double battery, but it would be more open to argument whether I was right or not than I care to leave the question. On the upper deck rests the light armament to be presently described: and being on this deck, our attention is at once directed to the rig. I have already stated the reasons which induce me to adopt a pure auxiliary rig, and in this case I propose to reduce the area of sail by about one-half, giving 12,681 square feet. But as area of sail may be expressed in terms of horse-power with a given wind pressure, it is quite certain that in reducing the sail-area by one-half, I am not reducing the assistance to be derived from the sails to anything like that extent, and moreover, that if my new sails be made of strong canvas, in fresh breezes I shall still spread as much sail as I did with a full rig. Again, the "Invincible" was crank enough to require 360 tons of ballast, with a moment of (say) 7,000 foot-tons. If I pull down the centre of effort by one-third, and reduce the sail area by one-half, it is pretty certain that I may take away the ballast without any fear of consequences. I want, in point of fact, the righting moment of the fleet ship to be small, for in that way alone can I have the steady platform required for her guns, and for the safety of her hull below, and this being so, I am bound to reduce the heeling power which large sail area and a high centre of effort would give. As to the shape of the sails employed, I know of no other so useful as the "leg of mutton" sail. Set upon booms, it gives a fine spread of fore and aft canvas, and is equally efficient as a square sail when the wind draws aft. Moreover, this rig offers the least possible resistance when the sails are not in use, and requires the lightest possible spars. It would be foreign to my purpose to go more into detail on this part of the subject, it is enough to say that I propose this rig for every ship in the Navy without exception.

49. Having thus given a general outline of the nature of my fleet-ship, her rig; how her hull and compartments are arranged; where armour is placed; and where and how the armament is distributed; I must descend to particulars in describing the thicknesses of the armour and the exact nature of the armament, and as I propose so tremendous additions both to the offensive and defensive powers of the ship, as to be startling even to myself, it will be necessary to set out pretty distinctly how these advantages are gained. In effect I am going to substitute twelve 18-ton guns in the "Outrageous" for the "Invincible's" ten 12-ton guns. I am going to put this armament under 10-inch and 8-inch plating, where the "Invincible" has but 6-inch. Besides, I am going to carry a complete light armament not under armour, consisting of four 90-cwt. 7-inch guns as bow and stern chasers, and sixteen 20-pounders as broadside guns. As to the

water-line belt, I intend to put 10 inches along all the vital parts of the ship, where the "Invincible" now has but 6 or 8 inches; the ends remaining as I find them in that ship, that is from 6 to 4 inches. In judging of the reasonableness of these proposals, my gains and losses in the matter of weights must be considered. In area of plating I gain very largely, as the "Invincible" has (say) 9,737 square feet of armour, whereas the "Outrageous" has but 6,098 square feet. In this way the armour and backing of the "Invincible" may be taken at 1,090 tons, while that of the "Outrageous" only reaches 917 tons. The armament of the "Invincible" only weighs (including ammunition) 370 tons, while that of the "Outrageous" will be 655 tons. On the whole, therefore, this vast change is made at a cost of only 112 tons in weight! It is seen at once that the removal of the 460 tons of masts and ballast, not only gives me this weight, but a very wide margin over it. I may now take the ship as a completed design, and then the following table will exhibit the distribution of weight in the "Invincible" and "Outrageous," enabling a complete comparison to be made between the two.

	"Invincible."	"Outrageous."
Hull	2,945	2,945
Backing	166	103
Armour	924	814
Guns and ammunition	370	655
Engines and stores	400	400
Boilers and water	360	416
Anchors and cables	90	90
Masts, yards, and sails	166	60
Coals	460	620
Stores	84	84
Ballast	360	—
Provisions and water	140	140
Boats and gear	20	20
Total	6,485	6,347

On an inspection of this table, it will be seen that after the ship is fitted out completely, there is a gain on the side of the "Outrageous" over the "Invincible" of 138 tons, and I suppose there would actually turn out to be this saving, for though there are some additional bulkheads which must be added to the weight of hull of the "Outrageous," there is also a good deal of bulkhead work which is omitted, and must therefore be put down in her favour. I also consider that there would be a larger gain on the rig than 100 tons, both from the lesser weight than 60 tons of the rig itself, and also from a reduction in the weight of the stores. Carpenter's and boatswain's stores in the "Invincible" stand at 64 tons, and much of this would disappear under the new rig. I want, however, about 120 tons more weight, which this surplus gives me, to be employed as armour on the deck over the vital parts of the ship. Taking the iron of this deck in "Invincible" at half an inch, 120 tons will allow me to add 1 inch to it,

so covering boilers, engines, and magazines with 1½-inch horizontal armour. This may be assumed to resist all guns lighter than the 12-ton at 10° impact, if indeed the 12-ton itself would actually "penetrate." It may here be observed that the "Invincible's" deck over engine-room, and fore-part of boilers, is now unguarded by vertical armour to shot striking at an angle of 10°, but with only half-inch iron to resist them. I think, however, that a great deal might be done towards protecting the boilers and engines from shot above water, by stowing stores such as chain cables, shot, and hemp cables upon the deck above them; but these are details to be afterwards considered, as they do not necessarily enter into the design. But before quitting the subject, it may be pointed out that owing to the height of the lower deck of "Outrageous" above boilers and engine-room, reserve coal may be stowed below it to form a ready support to the iron deck, and to intercept splinters of shell, &c. As to the chance of penetration by shot entering not far above water, and tearing the deck up without actually penetrating it, but so leaving the water to enter in a sea way through the hole in the side, and then through the rent in the deck into the body of the ship, it must be remembered, that in dealing with a leak through the deck, you are *outside* it, and can readily secure it, unlike a wound in vertical armour directly into the body of the ship, a wound whose great danger lies in the fact that it must be dealt with from the *inside*.

50. Let me now very briefly compare the fighting and propulsive powers of the "Invincible" and "Outrageous" in order to see whether there is any doubt as to the complete superiority of the latter. In the first place, the "Outrageous" will be able to get to her ground under circumstances when the "Invincible" could not do so by reason of her short coal supply. When on the ground, the "Outrageous" will be able to select and keep her position, having the greater speed.[1] Next while every heavy shot, fairly fired by the "Outrageous," will go clean through the "Invincible's" plating, no shot from the latter will penetrate any of the vital vertical armour of the "Outrageous." The "Invincible" will receive six heavy shots for every five shots she gives to her opponent. She will get two 7-inch shells for every two 64-pound shell she delivers, and she will get eight 20-pound shells for every one she delivers. If the "Invincible" plants a shell in one of the engines, or one of the boilers of the "Outrageous," that ship can go on with her other engine and set of boilers; but if the same accident happens to the "Invincible" she is done. If the "Invincible" is fairly rammed anywhere amidships, she is destroyed as a fighting ship, even if she does not sink. If the "Outrageous" is rammed, even if the inner skin is penetrated, it is very unlikely to destroy her fighting power, and most unlikely to sink her. If a torpedo forces in the double skin of the "Invincible" anywhere amidships, she will either sink, or be forced to abandon the fight; whereas there is no point at

[1] I have not considered it necessary to put the question of speed formally forward in this Essay, as I am very well satisfied with the moderate speed of 12 knots on the mile. It is of far more importance to be able to maintain that speed, than to exceed it, and then fall short of it.

which the explosion of a single torpedo will sink the "Outrageous," and only a small area under the middle line, between the pairs of magazines and engines, which will destroy her efficiency as a fighting ship. On the other hand, it may be argued that owing to the withdrawal of the armour between the belt and the battery of the "Outrageous," she is more vulnerable than the "Invincible" at that point; and so she is—to the 12-ton or lighter guns—but then the "Invincible," in this particular fight, is met by the 18-ton gun, whose shot will go readily through that part of the "Invincible" up to the full distance at which fire could be opened. The question is not whether the "Outrageous" is vulnerable or no: it is whether she may reasonably anticipate victory over any ship or ships of her own displacement. It may also be said that the "Invincible" when disabled in her engine-power may escape under sail, while the "Outrageous" cannot do so under similar circumstances. In answer it can be said that the fact as to the "Invincible" is not true, unless there is a very strong breeze, and then the "Outrageous" is as well off; but it must still be borne in mind that the "Outrageous" is only half as liable to engine derangement as the "Invincible." But if the design of the "Invincible" is to be upheld at all in this case, it must be alleged that she can compel her opponent to fight an end-on action. Then indeed she will have the advantage, for the two 4½-ton guns of the "Outrageous" cannot compare with the two 12-ton guns of the "Invincible." But the question is, how is she going to do it? The "Invincible" may turn end-on to the "Outrageous" and advance on her. She thereby may compel the "Outrageous" either to turn towards her, or from her. She will not turn from her, because this is to give the "Invincible" the advantages she asks for. If she turns towards her, there must be either a ram, or a broadside fight in passing.

The "Outrageous" is better able for the ram, and very much better able for the broadside combat in passing; for as a matter of fact, the "Invincible" having relied on her end-on fire, will only have four 12-ton guns wherewith to reply to her enemy's six 18-ton guns in passing. In a fleet, the case is still worse; for an "all round" fire cannot under any circumstances be employed in a fleet. Your friends, and not your enemies, surround you, and compel you to fire only in certain directions. When you are strong in certain arcs of fire, you may abandon the other possible arcs altogether, and in your tactical system fill them up with your friends. The ship like the "Invincible," which is weak all round, but still has an all round fire, sacrifices her tactical capacity, and some of her strength is necessarily wasted over arcs where her friends lie. Any attempt to make a hostile fleet fight an end-on battle must result in failure, if the hostile fleet can throw its whole force into certain arcs of fire, while the other has surrendered that capacity. When the "Outrageous" is withdrawn from comparison with a ship of her own displacement, and taken on her own merits, it will very possibly be alleged that in giving up the reserve of *armoured buoyancy* she adopts a fatal error. This, as we have seen, is not capable of assumption in a comparative test as against an

"Invincible," but it may be asserted of her as against a ship of the same displacement, armed with numerous light guns. Six inches above water, the "Outrageous" is penetrable to the lightest guns; but this penetration will not let water into the ship: it will at the most let the occasional wash of the sea in upon the lower deck, to wash out again by means of the non-return scuppers with which that deck is provided. The vital part of the deck is, as I have shown, not penetrable to light guns at all, and if the fore and after part is so penetrable, it is, as I have pointed out, equally repairable; and as for the wounds in the vertical side above water, they also are under control. But the argument against giving up the reserve of armoured buoyancy goes further than this, and urges that the ship may be sunk below her normal draft by the ram or the torpedo acting below the armoured belt. Then a ship without armoured reserve buoyancy is at the mercy of the lightest guns. It is true that if the "Outrageous" sinks by six inches of mean draft, she is then open to wounds from the lightest guns between wind and water, and if she is first sunk to that extent by not less than 180 tons of water being admitted below, she may be altogether sunk by a sufficient number of the lightest shot, provided that no means are taken to avoid that disaster. But these means are existing in the "Outrageous." In the first place she must sink 2 feet 6 inches, which represents more water than will fill both engine-room compartments[1], before the water admitted by light shot can flow over the deck at will, or down the hatchways. I should decidedly carry up the combings of many hatchways—those from boiler and engine rooms—by iron bulkheads with strong glass panes, to the main deck, and by this means remove the ingress of water below still further, so that it would require a great number of light shot to actually sink the "Outrageous." Thus the armoured reserve of buoyancy is not improperly given up. But I think it is altogether fallacious to argue in this way, on the actual merits or demerits, so considered, of ships of war. All ships of war are, and must ever be, destructible by some processes. That ship is the better type, which, while being less destructible than the other compared with her—which costs an equal sum—is more destructive. If this method of argument were adopted and firmly adhered to, we should long ago have reached a permanent type of war ship.

51. But I have to maintain my structure not only against the "Invincible" type, but against any other ship or combination of ships which can be launched against her for the same amount as she cost. Say the "Outrageous" will cost £250,000. Some other nation may propose to match her by unarmoured "Gammas." These "Gammas" to be effective, must carry the 18-ton gun, and will not, I suppose, cost much less than the others, or say £25,000. Ten of them may therefore be put afloat for the price of the "Outrageous." But what hopes can ten, or even twelve, "Gammas" have of mastering one "Outrageous?" She will certainly reply to them gun for gun; for she carries 32 guns, every one of which is effective against the

[1] They hold together to water-line, 684 tons.

"Gamma," and even her heavy guns alone number as many as are, or can be floated against her. We have in point of fact got in the "Outrageous" one form of this ultimate mean, of which I have previously spoken: a ship which cannot be met in an artillery combat with any prospect of equality except by a sister vessel, or by one or more vessels which in the aggregate cost more than the "Outrageous." But the ship is liable to be met by weapons supposed to be cheaper than guns: namely ram vessels pure and simple; and torpedo vessels pure and simple. We have already seen that the "Outrageous" is by her construction less liable to damage by these weapons than the "Invincible," but it must be shown also that she is less open to their attacks. It is her superior gun-power which effects this object, just as it made her less open to the attacks of "Gammas." Supposing the "Outrageous" to be approached by a light torpedo vessel from ahead or astern, the "Outrageous'" fire is more dangerous to her than that of the "Invincible," for the bow and stern chasers of the "Outrageous" can cross their fire to a very considerable angle, whereas if the approach is made the least on her bow or quarter, the "Invincible's" fire is practically inferior. But if, as would probably be done, the attack be repelled by broadside fire, the advantage is wholly and tremendously on the side of the "Outrageous." The pure ram will be armour-plated, and cannot be touched by the light guns of either "Outrageous" or "Invincible." If she therefore approaches either ship end-on, the "Invincible" has the better chance against her, provided the ram has no more than 8-inch armour. But if the ram carries 10-inch armour, the "Invincible" can do nothing with her either by bow or broadside. But it is pretty certain that the ram approaching on the bow or stern must expose herself to the broadside fire of a properly manœuvred ship, long before she draws near enough to make it dangerous to present the broadside to her. A ram, with even 10 inches of armour, will have some hesitation in running through the fire of six 18-ton guns, when she knows that her blow, even if delivered, will not be fatal. In any case, it is to be noted that the "Invincible" cannot touch her under such circumstances, whereas a single missile from the "Outrageous" may sink her.

52. Here I may leave my leading type of ship, on which I propose that all others, whether fleet-ships or smaller vessels, should be formed; but I must not quit her entirely without adverting to the question of her stability—a question which the naval architect at least will call upon me to answer. I have had neither the time nor the data necessary for accurate calculation, which indeed would be out of place here, but I have assured myself of the safety of my structure, by very simple and plain considerations. In removing the "Invin-"cible's" masts and yards, I took away from her a moment of 4,000 foot-tons above her centre of gravity, and in removing her ballast I took 7,000 foot-tons below it. I was therefore 3,000 foot-tons worse as regarded moments than before, but still 4,000 tons better than the "Invincible's" original design. In taking away the Invincible's batteries and armour, I removed 8,800 foot-tons of moment above the centre of gravity, but in placing the battery and armour in "Outra-

"geous," I gave her 10,000 foot-tons of moment, so that by all the operations to this point I had sacrificed 4,200 foot-tons of moment, but was still 2,800 foot-tons better than the original design of "Invincible." Additional powder in the magazines gave me 340 foot-tons, additional boiler power 560 foot-tons, additional coal 1,000 foot-tons, and so on, so that on the whole, I do not calculate on being more than 1,000 or 1,500 foot-tons worse than the "Invincible" when ballasted; then as I had so dealt with the sails as to reduce their heeling power by *two-thirds*, I conceived that I need not, in so rough an outline as this, go further. In any case I have left a very wide margin for possible errors. The raising of the decks will have had some effect to reduce this margin, but on the other hand the lowering of the gunwale and its attendant weights and other things which have not been counted, would tend to restore the balance. If the worst came to the worst the whole battery might come down lower, or even two guns, and the corresponding armour be moved. But I am of opinion that the stability of the structure is not materially compromised as it stands.

53. I have been very full, and as accurate as I consider permissible, in describing the "Outrageous," because she is strictly a typical ship for all the most important classes in our Navy. The first class fleet ship would simply be a larger ship of the same type. She should carry 25-ton guns, and 12-inch armour, and as her cubical contents would necessarily only grow below water, I take it that I am safe in assuming that 8,000 tons' displacement would give her twelve 25-ton guns. The upper-deck armament might be increased in numbers, but not necessarily in weight of metal. The object of her design would be, as in the "Outrageous," to meet any force of artillery which could be floated for her cost, on at least equal terms, and to throw back the chances of successful attack at sea by rams or torpedoes. It would be true that she could not meet an "Inflexible" on equal terms, but that ship would be met at less than her own cost by "Gammas," rams, and torpedoes, which she has not the same power of repelling as the "Blunder," by which name my first class fleet-ship may be referred to. A second class fleet ship meeting a first class fleet-ship would not necessarily fly from her, but it would be no disgrace to do so after a fair fight and a sufficiency of damage; something must always be allowed for the chapter of accidents, and the shot of even 25-ton guns must strike pretty fair to penetrate 10 inches of armour. On the other hand, a shell from an "Outrageous" might enter a "Blunder's" port, or explode down a hatchway, and might make it convenient for her to abandon the fight for the time. It is, however, not to be expected from my point of view that an "Outrageous," costing £250,000, should be asked to meet, in fair fight, a "Blunder" costing £333,000, though it is expected that an "Invincible," costing a like sum to "Outrageous," ought not to fly from her on the open sea; and it is said that if she must do this, she has failed in design.

54. The frigate of 4,000 tons would, on the same lines as the "Outrageous," be 245 feet long, 48 feet broad, with 19 feet 8 inches mean draft of water. I gather from the rough calculations I have

made, that she might carry 7-inch armour, where the "Outrageous" carries 10-inch, and her heavy armament would consist of twelve 6½-ton guns. Her light armament would consist of one 64-pounder as a bow-chaser, and one 64-pounder as a stern-chaser, with five 20-pounders on a side as broadside guns. The design of this ship would be to compel any intending opponent to carry at least 9-ton guns, and to give "Gammas," rams, and torpedoes as little chance as possible of successful attack. In strict analogy with the "Outrageous" and the "Blunder," the "Ramshackle," as I may call my frigate, ought to carry 9-ton guns, but I suspect I should find a difficulty in getting a 4,000-ton ship to carry twelve of them under 7-inch plating, though if it turned out that she could carry ten of them, it might be well to reduce her to that number. The difficulty in the 4,000-ton ship is height, and the moment due to it. There must be sufficient height to pass fore and aft under the battery in any ship on the design of the "Outrageous," but a proportionate height in a 4,000-ton ship would only give about 4 feet 6 inches between the water-line deck and the beams supporting the battery, which would be too low. The only way I see open is to increase the height to (say) 5 feet 6 inches, and to reduce the moment of the battery by a corresponding reduction of its weight, which would only give me twelve 6½-ton guns. The place of the "Ramshackle" would be in light squadrons, or single ships guarding the main commercial routes, and she would be intended to take the place of the existing unarmoured frigate.

55. I must pass rapidly on with the other classes of ships, for both time and space are beginning to fail me. The corvette class seems to my mind nearly properly met by the "Diamond" class, but the removal of the square rig would probably increase the steaming power and give the necessary coal supply. When we come to the smaller classes of ships we get out of the region of successful attack by rams, for they themselves would be rams of a handy size; and in a ramming combat the ram proper would not have greatly the advantage, hampered as she must be with armour to withstand heavy shot. So that in an encounter with a ram, which may be supposed to cost the same money as the corvette, the latter would fight fairly on an equality with the former, and so fulfil the *rôle* which I assume to be her's. The corvette—which I might call the "Venture"—would not use her guns against a ram proper, for that would be to throw away fire uselessly, but if anyone argues that she should have plate-piercing guns on purpose to meet such a ram, I ask, *cui bono?* Why should the ram not be met with her own weapons? Such a suggestion brings forward the wild controversy as to few heavy or many light guns. If the "Venture" were to have two or three heavy guns, say 9 or 12-ton, it is quite true that she might, with an odd shot, damage a "Ramshackle," but not an "Outrageous" or a "Blunder." But on the other hand, she must be beaten by a ship of her own class armed with twelve 64-pounders and two 4½-ton guns; this is a matter not admitting of argument, and quite apparent to those who agree with my preliminary dicta. But besides this capacity to fight her own class, or rather ships of her own value, she must push back the torpedo as far as may

be; and there is nothing but a multitude of penetrating guns which will make torpedo attack sufficiently risky to prevent it. It is the very absence of this preventive, which makes the monitor-class so tempting to the sneaking torpedoist. The corvette is even more open to these attacks than larger ships; for her lighter draught of water will push her closer in during times of blockade. But let it be known that, as well as a good look out, and giant bull's-eyes to scan suspicious surroundings, she has a *numerous* artillery ready for instant service, and the light and cheap torpedo vessel will think once or twice before she hazards an attack. The corvette should also be armed with at least two mitrailleuses, whose office it would be to represent short range shrapnel. The Gatling is an admirable weapon of its kind, but it is not so suitable for naval purposes as it might be. I have seen a mitrailleuse by L. Christophe of Brussels, which appeared to me a much more serviceable weapon for ships and boats, inasmuch as it could either be fired in single shots like the Gatling, or in a volley of 31 shots at a time, like the original mitrailleuse. Anyone watching the fire of the Gatling from a ship or boat *in motion*, must be aware that a very small number of rifles, I think seven, will equal its effect, as pauses must be made, almost between every shot, to relay. But in the rapid approach of torpedo boats, successive volleys accurately directed, will be much more effective than the somewhat wild fire of the Gatling under such conditions. In the corvette, and all the smaller classes of ships, where space below water is so important for boiler power and coal stowage, I think I should introduce in their engines an old principle in a new way. When the screw was first introduced, multiplying gearing was employed because it was not known how to get the requisite number of revolutions out of the engines. The plan was given up, partly because of the difficulties of multiplying gearing, but chiefly because gearing was no longer necessary. But now, when the number of revolutions of the engine can be so greatly increased, it seems to me that we should utilise that capacity. If the piston of a given engine travels twice as fast as it did before, it is certain that a cylinder of half the size will do the work of the original engine, subject of course to certain losses. But as weight and space are the two difficulties in the design of a war ship, anything which diminishes them may be freely accepted so long as no more than diminution of weight and space is developed. In another matter connected with the smaller class of vessels, the sloops, I have arrived at very definite conclusions. Without a certain relative draught of water, these smaller vessels would not fulfil their places even in peace time, and for the operations of blockade or attack on enemy's ships in shoal water, would be more or less ineffective. I think the sloop class ought not to draw more than 10 feet when crossing bars, and operating in shoal water. But on the other hand, I think it is a great mistake to inflict on general service sea-going sloops, the disabilities which a light draught of water carries with it in the open sea. I think therefore that the shifting of weights for exceptional service should be distinctly contemplated in the sloop class, and I should fix on fresh water, shell, and shot, as the weights most capable of being dealt with in this way.

The transference of a single ton from 60 feet abaft the longitudinal centre of buoyancy to 60 feet before it, representing a moment of 120 foot-tons, would have considerable effect, and I suppose that in ships prepared for it, the weights represented by water, shot, and shell, would effect the object. Supposing the sloop to draw 8 feet forward, and 11 feet aft, on an even keel she would draw only 9 feet 6 inches; but even less than that, as the water would be started overboard. I should not, I think, willingly allow guns to form a part of this shifting weight, for the use of the guns must be contemplated in shoal water. But if the intended variation of draught could not be obtained in any other way, I should endeavour to move the after broadside guns to ports where they would be equally efficient forward.

56. I am only now concerned to describe with some more particularity a typical "sloop" such as I desire to see. Her draught of water and her coal supply are the great limiting conditions of the sloop; armament remaining at first somewhat in the background. Speed is mingled with coal supply, but I suppose the sloop ought to get 11 knots on the measured mile. The coal supply I have already fixed at 4,000 miles for five knots, and the shoal draft of water at not more than ten feet. The sloop's armament would be somewhat more composite than that of larger ships, for it has to be borne in mind that while she may be met in the open sea by her fellow, and must therefore be armed principally in view of that contingency, she will also want something of longer range and of heavier shell for reaching into shoaler water than she can advance to, as well as for those land attacks which form the naval basis of our little wars. Hence her armament ought to contain one, or at most, two large guns, pivoting amidships, while she, like the corvette, frigate, and fleet-ship, wants a numerous light armament for the same purposes. I have, as in the case of the "Outrageous," taken a type from amongst our own ships, but it is not necessary to name her. She is about 600 tons, steams from 10 to 11 knots under favourable conditions at full speed, and can go about 2,000 miles in smooth water with her coal supply. She measures about 155 feet in length, and 25 feet in breadth, and draws when complete for sea, about 9 feet 6 inches, being a foot by the stern. Her armament consists of one 6¼-ton gun, one 64-pounder, and two 20-pounders, all mounted amidships as pivot-guns, the 20-pounders being at the bow and stern. The type is not unsuccessful, as these figures show, but her difficulties are that she is easily stopped in a sea-way, and cannot ensure making a full use of her normal steaming powers. Her spread of canvas (10,134 square feet of plain sail) of course assists her if she can use it, but she is naturally incapable of beating to windward, and her sail power costs her more than 20 tons of weight, that is, nearly one-third of her coal supply, and more than the weight of her guns. She is also short of boiler power, not perhaps for a short run, but she is short when speed is required for any continuance. Having but four guns in all, she is in a bad position to defend herself from those boat and torpedo attacks which her inshore position in time of war would call out, and lastly, she has, from my point of view, only half the coal that she ought to have. I pre-

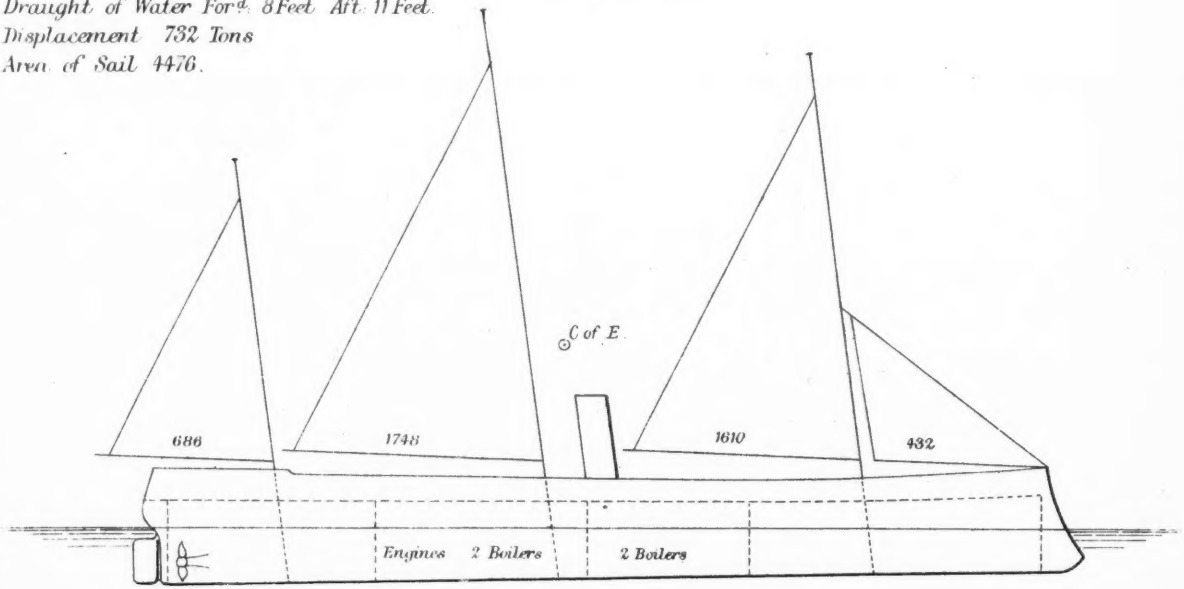
pose to modify this type to meet all the requirements of my ideal ship, by adding to the size of this ship about 140 tons, making her displacement 732 tons; and I propose to do this by adding 15 feet to her length, and a proportionate beam and depth. This will give me space for four boilers similar to the three carried by my model; space also for 140 tons of coal, or double the quantity now carried, and a more roomy upper-deck for the armament. As to the draught of water, I propose to bring the "Bantam," as I name the new type, three feet by the stern; making 8 feet forward, and 11 feet aft. Then by stowing water (10 tons) and shot (say 5 tons) abaft, I should expect to get movable weights sufficient to bring the ship on an even keel, or 9 feet 6 inches mean draught for inshore operations; for the weights moved would not affect her fighting power, and hardly her steaming power in smooth water, while in the open sea her screws would be 1 foot 6 inches deeper than in the present type. As to weights, I should get about 15 tons by the modification of the rig, and about 75 tons by the additional buoyancy, after deducting weight of hull. This 90 tons will give me the boiler at 17 tons filled; and the coal 70 tons; leaving my weights for armament as at present in the type adverted to, or, with ammunition included, at 31 tons 11 cwt. in all. The armament I propose for this weight would be two 64-pounders at 14 tons 12 cwt. together, and six 20-pounders at 14 tons 2 cwt. in all, making 28 tons 14 cwt., and leaving three tons for Gatling, or mitrailleuse, to be mounted, one on the poop and one on the forecastle in a nest of hammocks, or a coil of hawsers in action. Those who lay stress on single heavy shells might wish to vary the armament by substituting a single 4½-ton 7-inch gun for the two 64-pounders, but in my mind the other is preferable, and I should think that a "Bantam," armed as I propose, would have no difficulty in dealing with her older sister, armed as I have described. The exemplar would fire one 7-inch shell, one 64-pounder shell, and two 20-pound shells, as against the "Bantam's" two 64-pounder shells, three 20-pounder shells, and two Gatlings; but the exemplar would be in no condition to reply on her opposite broadside, whereas the "Bantam" would always have at least three 20-pounders to use, pending the transport of the others. But in repelling the attack of torpedo-boats, or boats attacking with intent to board, the "Bantam" would be immeasurably the superior of her examplar, and the sloop should be armed with peculiar reference to attacks to which she is peculiarly liable. Plates IV and V give the outline of the "Bantam," on which it is unnecessary to do more than remark that though the sail power is apparently reduced from 10,134 square feet to 4,476 square feet, the reduction is not so great in reality, for circumstances render it unusual for my exemplar to set more than 7,812 square feet as "plain sail."

57. I must advert for a moment to the gun-boat and other special classes, before quitting this description of my ideal navy. I do not think that the gun-boat should be looked on as a sea-going ship. Draught of water is the be-all and end-all of the gun-boat, and it should not exceed 6 feet. At such a draught, sea-going qualities, coal

Length at Water Line 170 Feet.
Breadth Extreme 27·3 Feet.
Draught of Water For.d 8 Feet Aft 11 Feet.
Displacement 732 Tons
Area of Sail 4476.

H.M.S. "BANTAM"

Scale ½ ins. = 1 Foot.



J. Jobbins

H.M.S. "BANTAM".

Scale, Six ins. = 1 Foot.

PLAN OF UPPER DECK

PLAN OF LOWER DECK &c.

J. Tobbins

capacity, &c., must not be looked for, and the attempt to find them is almost sure to terminate in ultimate deep draught, so that in the result we get an inferior sloop instead of a superior gun-boat. Gun-boats can be worked as tenders very effectually on most stations, and as their functions lie at the very extremities of our naval nerve filaments, they must not be expected to take their place elsewhere. Despatch vessels of great speed, and great coal capacity—able to steam their 4,000 miles at a high rate, are acknowledged necessities—but they are despatch carriers and nothing more, so must not be looked on or treated as fighting ships. I have already stated that I do not think it is the business of Great Britain to develop the torpedo attack except as a sea expedient, and I am conscious of yielding against my better judgment when I allow that for the satisfaction of home communities money may be spent on outrigger torpedo boats, and on rams—if they can be very cheaply turned out, whose office it shall be to lie at the great commercial ports at home, and in those of India and the larger colonies. I grudge every penny withdrawn from the sea-going fleet, for I know in that alone lies our safety, but I would yield a very small sum to the popular mistake.

58. I promised at the outset (paragraph 18), that I should found our war navy on our peace requirements, and having described a complete navy such as I think would meet our war purposes, I must now show that such a navy does not so greatly differ from that now existing, which merely wants the backbone of my central idea, to be brought into harmony with it. I have turned to the sea-going navy abroad on the 1st January, 1877, and I have classified the ships, as though the classes corresponded to those which I would adopt, looking to their tonnage and draught of water as my principal guides. As we stand at present there is little correspondence between these elements and the power of the ship, but there must be a very considerable correspondence between them and the *cost* of the ship, so that my classification is fair. I find then that we had abroad on the 1st January, 1877, excluding ships on passage out to relieve others:—13 fleet-ships; 12 frigates; 18 corvettes; 38 sloops; 16 gun-boats; and 8 despatch vessels. The fleet-ship varied in displacement from 10,275 to 6,010 tons; the frigate ranged from 5,152 to 3,060 tons; the corvette from 2,431 to 1,542 tons; the sloop from 1,108 to 529 tons; while the gun-boats varied from 455 to 330 tons. The draught of water of the fleet-ship varied from 27 feet to 23 feet; of the frigate from 24 feet 6 inches to 20 feet 2 inches; of the sloop from 14 feet to 8 feet 2 inches; and the gun-boat from 10 feet 5 inches to 8 feet 2 inches. It may be seen from this statement that not a great deal of change is asked for to complete the Navy in its symmetrical form, and that if a definite classification such as I propose were adopted, we should hardly have the anomalies which are now too often to be found. The variation of from 10,000 to 6,000 tons in the fleet ship is probably greater than we should find if a definite idea of the duties of fleet-ships as a class obtained. The frigate, again, is sometimes a small fleet-ship, and sometimes a large corvette. It is surely a waste somewhere if we find one sloop of 1,100 tons carrying only four guns, and

drawing 15 feet 8 inches of water, another of 950 tons and drawing 14 feet, but still carrying only four guns, while another carries nearly the same armament, displaces only 600 tons, and draws but 9 feet 6 inches of water. Then if the sloop of 600 tons draws but 9 feet 6 inches, surely the gun-boat of 450 tons should not draw so much as 10 feet 4 inches. But of all the 38 sloops scattered over the world, and on whom most of the burden of protecting our commercial routes must fall, I suppose there is hardly one which could steam 1,500 miles against a moderate breeze such as a trade wind or a monsoon, while the corvettes, frigates, and fleet-ships are only in rare instances in better case. My aim is that the ships should be more powerful as weapons, and should be able to transport themselves from point to point in a shorter time than at present, and when these two things are accomplished, I conceive it will be time to consider the economical question, which, or I am grossly mistaken, will be found to bear an answer in my favour.

59. The peace distribution of our present Navy gives a very perfect foundation for the organization and distribution of that which I propose in time of war. The fleet-ships which now form our Channel and Mediterranean squadrons, would, with augmentations, throw themselves upon the coasts of the enemy, and present outside each of his war ports, a force at least equal to his own. The failure of any blockading squadron to shut up its opponent in his own port must be communicated by the despatch vessel and the telegraph to the authority in command. This authority must bring up his supports, and the escaped squadron must be met at sea. So long as it is intact on the high seas, it breaks our communications in that direction, and commerce can only be re-established by its defeat. Lighter ships, frigates, corvettes, and sloops, would guard the inshore passages from war ports and prevent the exit of the enemy's "cruisers" to prey on our commerce; light ships of these classes would also watch the smaller ports where there were no fleet-ships, or perhaps any war ships of the enemy, but whence "Alabamas" might otherwise issue. Resting on Gibraltar, Lisbon, Madeira, and the Cape de Verdes, light squadrons and single ships would patrol the great southern trade routes, and keep them free of the enemy's wandering ships or squadrons; while St. John's, Bermuda, the Azores, and the home ports would equally furnish and sustain single light ships or light squadrons to guard the great western routes. These forces would be under single commanders, who would each be responsible for preserving the routes under his control intact. If any Mediterranean power were at war, or likely to be at war with us, then a proportion of fleet-ships must observe those ports where fleet-ships lay; otherwise, the route through the Mediterranean could be guarded by lighter ships resting on Gibraltar, Malta, and Port Saïd. Passing to the more distant but smaller commercial routes, the West Indies would be guarded by suitable light ships, of which the present West Indian squadron would form the nucleus. The present West Coast squadron would be the foundation of that force of light ships which would patrol between the Cape de Verdes, Sierra Leone, Ascension, St.

Helena, the Cape, and Natal. To the East India squadron would be appointed the routes from Aden to Penang in the east, to King George's Sound in the south-east, and to Mauritius in the south. The Red Sea, guarded at each end, would require no English force in it. To the present China squadron would fall the defence of the Straits of Malacca, of Singapore, and the routes north-east and south-east therefrom, while the Australian squadron would guard the coasts and routes as far east as Fiji. Passing back again, we find the beginning of a squadron in south-east America, which when strengthened, would rest, in the absence of alliances with Brazil and the South American States, on the Falkland Islands, Trinidad, and Fernando de Noronha. A strong section of this force would carefully watch the Straits of Magellan, and so guard the Pacific routes from western intruders. The Pacific itself would be guarded by the Pacific squadron, to be increased as much as necessary. Thus we see that really the instinct of the nation has prompted it everywhere to form a basis for the protection of its commercial routes in time of war, and it therefore only remains to continue to develop that instinct in proper directions.

60. I may now suppose a strong European coalition against us, and proceed to particularize more distinctly our position at the moment of the outbreak of war, supposing that it came without much warning. I assume that France, Russia, Germany, and Italy, are banded together against us, and propose to deal with that hypothetical and very remote contingency. France and Italy are Mediterranean powers, and the ports of Venice, Ancona, Castellamare, Spezzia, Genoa, and Toulon, would require squadrons of fleet-ships in observation and blockade. Russia could not enter the Mediterranean except by alliance with Turkey, or by forcing the way through our fleets to the Straits of Gibraltar. It may be said, perhaps, that Italy would have in her ports three first class and five second class ships, while France might have four first class and six or eight second class fleet-ships. Remembering that many of the second class ships, like our own "Warrior" and her contemporaries, are penetrable by the 6½-ton gun, and that therefore a frigate such as the "Ram-"shackle" would be an answer to them, we see that the force of fleet-ships in the Mediterranean necessary to confine these enemies in their own ports would not be impossible even now to collect. Perhaps sixteen fleet-ships and a proportion of frigates would be a sufficient guarantee for the safety of the Mediterranean commercial route; a force of corvettes and sloops remaining to patrol between Gibraltar, Malta, and Port Saïd. Now, in the Mediterranean, at the date I have chosen, we had six powerful fleet-ships and four frigates, besides one corvette, three sloops, and four gun-boats. If I use the term "ironclad," then I must say there were ten of them, many of whom would match ships of the enemy which I have counted as fleet-ships. But the displacement of these ten ships came to 62,854 tons, which divided amongst the proposed fleet-ships at an average of 7,000 tons each, would give nine efficient fleet-ships all practically impervious to anything under the 18-ton gun. An addition of seven fleet-ships

to the existing Mediterranean fleet might therefore be held to secure that sea, were the ships built and classed as I propose. If to this force were added a corvette, and three sloops, the highway could be guarded very efficiently, while a few frigates and corvettes would watch the ports, such as Venice, capable of fitting out "Alabamas," but incapable of despatching more powerful ships. Altogether, we may say the sixteen fleet-ships, six frigates, four corvettes, six sloops, four gun-boats, and two despatch-vessels, would almost guarantee the security of the great eastern route from Gibraltar to Aden; the addition to our existing force being seven fleet-ships, five frigates, and three sloops. Let us now proceed up the coast of Europe, where, passing by Spain as neutral, and Portugal as friendly, we come to France as an enemy, and to Rochfort as the first war port which we meet. Here, however, we cannot meet the fleet-ship, as there is not water for her, so that no ship larger than a frigate is needed to blockade the Charente. L'Orient is the next war port met with; but here again a heavy blockading force would not be necessary, as I gather that at high water spring-tides there is no more than 29 feet water at the entrance. The port could now hardly be used for the collection of first class fleet-ships. At Brest, however, we may expect to find at least an equal force to that which we found at Toulon, say twelve fleet-ships, to which must be opposed in observation twelve of our own. We find our Channel Squadron to consist of four fleet-ships at the date selected. There were besides in the Home ports as a reserve, or otherwise in commission, ironclads, or their representatives, to the number of ten; therefore we should be able to deal with the coast of France as far as Brest in the matter of fleet-ships, and yet have two to spare for Cherbourg, where we might also expect to find twelve fleet-ships. An addition so far of ten fleet-ships to any existing force in commission for the Channel, and of seven for the Mediterranean, would therefore be a reasonable requirement to protect our southern and eastern commercial routes from absolute breach by hostile fleets under the conditions named. We have next to deal with Wilhelmshavn, where we may assume one-half of the German Fleet to be assembled; say, three first class, and three second class fleet-ships, to be observed by six of our own fleet-ships. Entering the Baltic, we come to Kiel, where we suppose there are five German fleet-ships, calling for five of our own to observe them. Then we come to the Russian ports of Sveaborg and Cronstadt, with perhaps a single first class fleet-ship, and twelve second class of very inferior metal and plating. Possibly ten of our own fleet-ships would be sufficient for their observation. Upon the whole, therefore, we see that with a fleet of 62 fleet-ships, we could undertake the blockade of all the Italian, French, German, and Russian ports, whence foes worthy of their steel could be expected to issue. That is not so great a number, when we remember that we had at the time chosen for comparison, about 48 ironclads, at least as competent as those I have assumed to be arrayed against us. As to the numbers of frigates, corvettes, and sloops, which would be required to watch and blockade the smaller ports, I need not enter on so hopeless an estimate. I assume an imperfect blockade on this

head, and suppose that if there were any hopes of a successful attack on our commerce by frigates or smaller vessels, with reasonable hopes of safe return, such ships would find means to escape our guards. But the very root of my position is that a proper development of our existing resources will make it hopeless for anyone to attempt "Alabama" raids. So far we have got now as to show the forces necessary to obstruct the issue of hostile *fleets* against us, and to prevent their junction in so overwhelming a force that our patrols along the lines of commerce must abandon their duties. I have also shown how small a force may guard the Mediterranean route when once the heavy ships are blockaded. If four ships are known to be lying between Gibraltar and Malta, and four more between Malta and Port Saïd, she would be a sanguine "Alabama" who should hope for a successful career on that line. I may now turn to the more distant commercial routes and their protection.

61. I have said that the squadron in the East Indies would be charged with protecting the eastern routes from Aden to Penang, to King George's Sound, and to Mauritius. Now the forces of Italy, or of Germany, must reach this field of operations by running the gauntlet round the Cape of Good Hope, or Cape Horn; on their route they would meet, even now, the most tremendous difficulties. There lie in wait for them even in peace time, the West African Squadron of 9 sail, and the South American of 3 sail, while they could not easily obtain coal from neutral ports on a track so watched. France, however, has at Bourbon, Pondicherry, and at Saigon, ports of her own which must be watched, while Russia has her ports and existing squadron in the North Pacific. Russian Siberia and French Cochin China would be for the observation of the China squadron of which I shall presently treat. Bourbon and Pondicherry would each require the presence of perhaps a single ship, resting on Mauritius and Trincomalee. Looked at thus, it may be seen that a very small force is necessary in the East Indies to keep our trade routes inviolate; and the present force of 1 frigate, 4 corvettes, and 7 sloops, might be actually reduced when the graver policy of a European war supplanted those smaller matters which now keep up the East Indian squadron at its high standard. With such ships as I propose, which could throw themselves at very considerable speed on menaced points, a greater concentration at the Cape of Good Hope would be a reasonable way of protecting the East Indies. Singapore and the Straits of Malacca form so inviting a sluice valve to check the waters of our commerce, that we may almost be sure that a serious attempt to get hold of the handle would be made there, if anywhere in the East, by the powers I have named. It can be approached from so many directions, that the powers in consultation might very readily agree to make a junction of all forces there on a given day, each sending perhaps two or three times as many ships as are necessary, to make up for certain losses on the way. I think therefore that some concentration of our ships should be made there, and this brings me to the consideration of the China squadron and its duties. It consisted at the date named of 1 fleet ship, 3 corvettes,

15 sloops, 4 gunboats, and a despatch vessel. Here is really a very fine force if the sloops were as efficient in their powers of locomotion as I propose they should be. If a corvette and 3 sloops watched the chief Russian port in Siberia; if the fleet-ship watched an enemy's fleet-ship say at Saigon; if she were supported according to the force found there—say with 1 corvette and 2 sloops; and if 4 sloops were left along the route from Hong Kong to Japan, we should still have 1 corvette, 6 sloops, and 4 gun-boats to protect the route from Singapore to Hong Kong, and to guard Singapore itself. It is not probable—if only the ships were as I wish them—that any addition to the peace establishment in China would be necessary in war time; for, as in India, the smaller local wants of peace must immediately give way to the exigencies of an Imperial policy in war. In Australia we should probably want an addition to the 3 corvettes and 1 sloop which now represent our naval forces there, and I think that if we took that of the 4 frigates of the detatched squadron which existed at the date named by me, and placed them under the command of the Australian Admiral, together with two or three sloops, Australia would be left reasonably secure. The Pacific trade route is perhaps the most difficult of all to guard, and I think it very probable that much would have to be done by way of convoy. The route is liable to attack from the bases of Siberia by the Russians, and of Tahiti by the French, and it is difficult to see how the successful raids of *sailing* "Alabamas" on a *sailing* trade are to be prevented, the means of concealment and escape being so complex in so great an expanse of ocean. Convoy for the sailing trade would therefore appear to be a necessity, and the probability is that the traffic across the isthmus would be increased, while that round Cape Horn would be diminished. The Siberian fleet being thoroughly blockaded; and Tahiti, the Marquesas, and New Caledonia thoroughly denuded of possible "Alabamas," the Pacific trade would only be open to the attack of "Alabamas" fitted out in the neutral ports of Pacific America. It would be dangerous for the smaller States to permit such proceedings, while America might be relied on—in view of her own "Alabama "Claims"—to take care that nothing touched us from a United States port. But the existing Pacific squadron of 1 fleet ship, 2 corvettes, and 5 sloops would be properly augmented by at least a corvette and 3 sloops in a war with European powers. Returning home again we pass to the Falkland Islands, on which the present force of 1 frigate and 2 sloops would, when augmented, rest in time of war. This force would be in some degree united with that on the West Coast of Africa, now amounting to 1 frigate, 2 corvettes, 1 sloop, and 5 gun-boats; and I think it would be well, seeing the value of the two great commercial lines which pass there, to unite the two squadrons as a South Atlantic naval station. Even in peace the South Atlantic squadron of 2 frigates, 3 corvettes, 3 sloops, and 5 gun-boats is respectable, and if called in upon Ascension, St. Helena, and the Cape, would show a very fair guard there. But a concentration would probably be required at Ascension, as at the Cape and the Falkland Islands, as these three points form as it were the necks of the

navigation, and if sufficiently guarded, expeditions for more distant parts of our empire might there receive a check. The West Indian and North American station is now provided with 1 fleet-ship, 1 frigate, 3 corvettes, 4 sloops, and 3 gunboats, and these with augmentations would rest upon St. John's, Bermuda, Nassau, and Barbados, to receive the streams of commerce flowing east and west, and to purify those routes from the incumbrance of chance "Alabamas." New squadrons not now in existence would be required to guard the routes nearer home, but it would be found that they would be best disposed in a line running from Cape Finisterre to Cape Clear, and resting chiefly on the home ports. A chain of a dozen corvettes and sloops lying along that line would make a very efficient curtain to strain out the gnats which might wish to feed beyond that line on forbidden fruit.

62. I think that this cursory survey of our existing position in peace, and of our probable position in a war with four great maritime powers combined against us, is very reassuring in some respects; in others very much the reverse. If we took our present peace displacement of ships in commission, and their armaments, we should be very well satisfied; but if we look at their powers of locomotion we ought to fear. To have a force, and yet to be unable to employ it in the right place at the right time, is the ultimate blunder of bad generalship. That we should go on deliberately constructing naval forces with this flaw in them would very much surprise the ignorant. It is no surprise to those who recognize the force of the past in influencing the present. It will still be years before the great change I propose is made complete, but there is no year passes which does not more closely approach it, and if war does not come in the meantime, we shall not so greatly suffer. With ships designed as I propose they should be, our peace establishment ought to show such a front as will give us a secure basis against any possible combination in war.

63. I should add a word or two here on the fourth division of my subject, having treated of the first and second—I mean "Colonial "and Home Defence." In the whole of my scheme I have assumed the security of the coaling stations, and I conceive that if a sufficient naval force is afloat to protect the line of communication between each pair of coaling stations, that act will protect the stations themselves. I find myself unwilling to withdraw from the fixed fund which I assume to be at our disposal, any part for the exclusive use of the coaling station, which might be employed to augment the sea-going fleet. But to be reasonable, I must admit the possibility of attack on a naval station in spite of its sea-going guard. I am only concerned then to meet this possibility in the cheapest way possible. And I think this way involves the following principles. (1.) Coal and other stores protected from shell-fire on the sea side. (2.) A garrison of sufficient strength to meet the ordinary landing parties of one or two frigates. (3.) Cover for that garrison. (4.) Stationary torpedoes where capable of application. (5.) Locomotive torpedoes either of the outrigger, or fish description. I should expect to get

news beforehand of any serious expedition against a naval station, and with ships capable of steaming at a moderate speed for a long time, I should always calculate on their assembly to defeat such an expedition. I should only give such a defence to the naval station itself, as would make its attack either useless or hazardous to anything short of a serious expedition. But I put much faith in the sea-going fleet resting on the naval station as a protective force, and little faith on any other appliance. The larger colonies are and must be in the hands of armies. The smaller colonies exist as the supports of a navy as an Imperial instrument. The larger ones and India exist as integral parts of the Empire itself. The first become parts of the Navy, and should in my opinion be entirely under naval control. The second can be attacked only after the failure of the Navy and must then be defended by an Army. Colonial and Home ports which are open to attack as a means of directly damaging the Empire, should be guarded by the Navy in sufficient force, while those naval stations which will be attacked as a means of indirectly damaging the Empire through the Navy, the Navy is doubly bound to protect. But as I have already said, I should allow to all ports open to attack, a certain sum to be expended in the cheapest defences, which appear to be the different classes of torpedo. I wish to condemn again with steady design the idea of the "Harbour Defence Ship." Such vessels are every whit as likely to be withdrawn as the sea-going ship when they are wanted, and the only result is that you build a bad sea-going ship when, had you never heard of harbour defence, you would have built a good one. The very extreme to which I would allow myself to go, would be in the ram and the "Gamma;" but these weapons, if prepared at all, would be for the great home, or the great colonial, ports.

64. My task, which has been but badly and hurriedly performed, will now be done when I have said a word about the Naval Volunteer Force; but when I have thrown local Home and Colonial defence entirely on the torpedo, I have already made the supplemental force a corps of Volunteer Torpedo Men. I think it was always difficult to say what the functions of a Naval Volunteer force should be, so long as it was thought that they must serve on board ship. But now, if they are the defenders of great ports by torpedoes, we have for them a function such as their educational status will eminently fit them for, and an exercise for their skill and daring in time of war, which might be the envy of the highest genius. I am strong on spending little on harbour defence, and I therefore recognize in the Naval Volunteers that very element which I seek, and if the enemy is to be kept at bay by a home defence of any kind, I should think that a cordon of coast torpedoes, fixed and locomotive, in the hands of a British Volunteer force, will do it.

65. I have now concluded my essay, and as a final paragraph may summarise my views in a series of theses which may form the bases of discussion should I be so fortunate as to see my essay amongst those selected for publication. The theses are these:—

(1.) A frank reliance should be placed on steam power; and coal in naval depôts.

(2.) A classification of our ships should be adopted, and the types should be reduced in number.

(3.) It is an error to suppose that the disappearance of armour is approaching, and equally an error to suppose that guns of 80 tons and upwards are the weapons of the future.

(4.) No nature of torpedo will greatly alter the tactics of a modern sea fight.

(5.) It is possible to subordinate the requirements of a peace establishment to those certainly required in war, not only without an increase in the Estimates, but with a possible reduction.

(6.) Coast and harbour defence should occupy in the British Empire an entirely subordinate position, and the best defence of naval stations is the defence of the routes communicating with them.

LECTURE.

Friday, February 1, 1878.

W. STIRLING LACON, Esq., Vice-President, in the Chair.

ON SOME OF THE MAIN CAUSES WHICH LEAD TO THE FOUNDERING OF SHIPS.

By Vice-Admiral E. Gardiner Fishbourne, C.B.

Shocked by the report that thousands of lives were annually lost at sea, I examined the "Wreck Register," and found that this was so true as to make it incumbent upon every sailor to seek a remedy.

There ever will be wrecks arising from carelessness, ignorance, fogs, changes in currents, collisions, and unexpected gales, but these are beside my object now, though the losses on these accounts with care might be largely reduced.

Striking facts point to radical defects.

In 1874, of casualties at home, 338 happened to nearly new ships, 646 to ships of from three to seven years of age, 961 to ships of from seven to fourteen years of age. Rottenness can have no part of the blame here! In the same year casualties occurred when the wind was such that a ship could carry top-gallant sails, 656 when the force of the wind was only such that a ship ought to be able to hold on her way, and only 952 with the wind at and above a strong gale.

We must, therefore, seek some other causes than stress of weather, rottenness, great age, or weakness to account for the great proportion of the losses of life and property.

These, in the main, will be found to be insufficient stability, in which other defects are involved, as unsteadiness, limited power of the helm, and improper stowage, taken in its widest sense.

Some will say, how can these affect old and rotten ships? I answer, such may be doomed; give them little stability, and stow them badly, and their doom will be accelerated; the contrary will prolong their lives and afford the crews greater chances of escape.

Every ship is necessarily subject to wear and tear; distribute their weights badly, and they will carry in them an accelerating force of disintegration; out of the best weather they will make bad, and of bad worse, without any profit to compensate.

A rotten ship may be safe to reach little further than outside the port, then go down; this equally occurs to good ships from deficient stability, as for instance, to the "Stuart Hahnemann," a new merchant ship of 2,500 tons, to the "Tacna," a steam vessel, and to the "Captain," of the Royal Navy; the "Invincible," not without reason, was thought to have been in like danger.

It is equally distressing and injurious to public interests whether the loss of life and property arises from the bottoms falling out, or from the vessels capsizing.

Hundreds of vessels leave our ports said to be seaworthy, yet are not so; some of these for a time make voyages safely, the time comes when they fail; this need not be.

It is clear from the testimony given after losses, that captains are often forced to ignore their own true experience, and accept opinions said, without reason, to be scientific.

No such obligations should be forced on them, nor would they, were it understood that the interests of the ship-owner, of the underwriter, and of the crew are inseparable, and that experience is more to be trusted than any theories.

Before commencing this paper, it will be necessary to review of that by Mr. White, read in this Institution,[1] as he takes an opposite view; indeed I am obliged to go to the Navy for data. He says "that con-
"siderable anxiety was felt, and expressed in many quarters, as to
"the *safety* of ships burdened with great weights of armour; and
"it was generally assumed that they must roll heavily. These opinions
"were not shared by the designers of the ships, &c. The French led
"the way, our own Channel Squadron trials soon followed, and it
"was speedily shown that the popular belief was not well founded, all
"or nearly all of the ironclads proving at least as steady as the screw
"line-of-battle ships."

This opinion is contrary to facts and to admitted principles, Mr. White and his coadjutors being witnesses. Admiral Paris says of the French ships, "the new broadside ironclads are *worse rollers* than the
"old vessels used to be, and even in moderate seas bring their guns
"under the waves."

Mr. White recommends a reduction of the stability in order to reduce the arcs rolled through, or as Mr. Froude expresses it, so that the largest waves would fail to roll them. Mr. White says, "the reduc-
"tion of stability or stiffness was made *advisedly*, in order to increase
"steadiness. The French designers have followed a similar course.
"Their latest completed ironclads, the 'Océan' class, have no
"greater stiffness than our 'Vanguard' class had before they were
"ballasted."

Truth is said to lie at the bottom of a well, so deep as respects this modern theory of rolling, that it is difficult to reach.

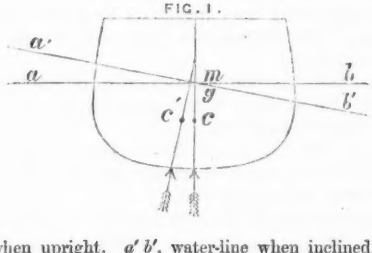
[1] See Journal, Vol. xxi, No. 92, page 933, *et seq.*

The "Vanguard" was not deemed to be seaworthy, till her stability was increased by 340 tons, when this has been necessary for the "Océan" class there will be a parallelism—not before.

Meta-centric height is no measure when the ships are so entirely different as *these* are.

The meta-centric height is the distance of the point of intersection of two lines of support, above the centre of gravity, *i.e.*, a line when the vessel is upright, another when inclined. See Fig. 1.

FIG. 1.



a b, water-line when upright. *a' b'*, water-line when inclined. *c*, centre of displacement. *c'*, centre of displacement when inclined. *m*, the meta-centre. *g*, centre of gravity. *m g*, meta-centric height.

Though Mr. White recommends raising the centre of gravity and distributing the weights to the sides, in order to reduce the arc rolled through, there is no instance on record,—nor could there be,—if mechanical principles are true, where that has been done, all other things being left unchanged, whatever the size or form of the ship, that she has not rolled through all the larger arcs.

Sailors know full well that running guns in from the sides and lowering all the top weights in bad weather, have always contributed to the ease, often to the safety of ships, as they then rolled through smaller arcs—wooden ships soon let you know this by the relief given to their *creaking bones*. The only apparent exception proves the law, that is, where the weight is too low and too centralised, then the rolling is too quick, short, and jerky for masts and fabric.

There is no warrant for the assertion that old ships rolled more than the armoured ships, still less that there is any truth in this new theory.

The "Albion" peg-top rolled more than any other, she rolled only 47°. But Mr. White informs us that "Lord Warden" rolled 62°.

Mr. White gives a theory of wave-motion and supposes a tiny raft to take the place of a surface particle, yet does not affirm that the raft passes through the gyrations common to this particle—only that it is generally influenced by these motions. He asserts, however, that an observer standing on this raft would be so influenced by its motions that to him the mast in it would appear to keep truly vertical, and the raft to remain perfectly steady, while it might be rolling through an arc of say 15° or 20° once every four or five seconds—not, however,

offering any proof of this, still less any proof that a ship that substitutes in space millions upon millions of these particles can by any means follow the gyrations, or be sensibly influenced uniformly by one or more of them, moving with velocities enormously different, many of them moving in opposite directions.

Were it so, the rolling motions of ships would not tend to disintegrate their structures, nor would their masts ever be rolled away, but we all know the case is otherwise.

Mr. White seems not himself satisfied with his assertion, for he says "no ship exactly fulfils the condition of the *assumed* raft—happily it "is so—neither could any such raft do so, particularly when it has "parts *above water*, which make a radical difference in the whole "problem."

Yet this is the smallest defect as far as any argument reaches, for in this theory there are but two forces alluded to—gravity of the particles and the centrifugal force. Yet the buoyant force exists and the particles roll on each other, for the gravity of the adjacent water produces buoyancy; but why is it omitted here? and the greatness of the pressure on the particles low down is shown in their almost motionless condition, a fact overlooked in this theory. In a word, the theory does not fit the facts.

If a person standing on the suppositious raft could consider the raft to be still, when rolling 15° each way every four or five seconds, it could only be by the centrifugal and centripetal forces balancing each other, as in the case of the earth; and if so, then a gun on its carriage and shot if unsecured, would not roll to the lower side during such rolling; nor, indeed, would a pendulum indicate any angular motion. If any one has had such an experience they may believe it, but they will say they would not have believed it had they not seen it, and will allow us the same liberty; we need not pursue this further till proof is offered.

We pass to consider Mr. White's table. He says, "reduction in stiff-"ness lengthens the period, increase in the moments of inertia has the "same effect; general experience confirms the teachings of theory, "that on the whole the ships with the largest still-water periods are "the steadiest in a seaway; out of the many cases on record, take the "following":—

TABLE I.

Squadron of 1871.	Approximate still-water periods.	Mean arcs of oscillation.
	Seconds.	Degrees.
"Lord Warden"	5 to 5½	62
"Caledonia"		57
"Defence"		49
"Prince Consort"		46
"Northumberland"	7 to 7½	38
"Minotaur"		35
"Hercules"	8	25

French Expeditionary Squadron, 1863.	Approximate still-water period.	Arcs of oscillation.
	Seconds.	Degrees.
"Normandie"	5 to 5½	43·6
"Invincible"		41·4
"Couronne"	6	37·7
"Magenta"	7 to 7½	36
"Solferino"		35

Detached Squadron of 1875.	Approximate still-water period.	Arcs of oscillation.
	Seconds.	Degrees.
"Newcastle"	5	29·6
"Topaze"		22·6
"Immortalité"		20
"Narcissus"		19·6
"Doris"		18·7
"Raleigh"	8	5·8

The only data given in this table are the period and the arc of roll, and as *they* are given to prove the value of less stiffness and greater moments of inertia, we understand that it is implied that these are the sole causes of the differences in angular motion.

We are not told which of, or whether both of the opposite theories above mentioned, are supposed to be illustrated by the tests here recorded. The fact being that neither the theory nor the opposing law above mentioned are herein illustrated, for the greater or less angles of roll of these ships have no relation to periods greater or less, nor are the two elements alluded to, the main causes of the greater or less arcs. To the extent to which they operate, they are opposed to Mr. White's theory.

Before proceeding further we must repeat that Mr. White, by the word "steadiest," means the ship which rolls through the shortest arcs, and he gives these ships with their corresponding arcs and periods in proof.

But this is the opposite of that above stated, that "as the stiffness "is reduced and the moments of inertia increased, the periodic time is "increased and with it the arc of roll." The Scientific Committee on Designs say, "as the angle of roll increases, the periodic time in-"creases." Equally as the periodic time increases, the angle of roll increases—or to put it in other words—as stiffness is reduced by raising the centre of gravity, and increasing the moments of inertia, the periodic time and angle of roll are both increased, and the ship made more *un*steady!

Now, the new theory is, that as the stiffness is reduced and the moments of inertia increased, so the ship is made more *steady*, or rolls through smaller arcs; we shall see! Yet, taking each table by itself, it does not illustrate the law of the pendulum, but flatly contradicts it; for the shortest arcs are opposite the longest periods!

Establishing that, there are elements in the problem that these tables refer to, more influential than moments of inertia or meta-centric height, and to which are due the apparent anomaly.

Why Mr. White should give this table as illustrating that raising the centre of gravity reduces the arcs rolled through, I do not understand, since he has not given the meta-centric height, which is indispensable evidence; still less can I understand how it proves that increasing the moments of inertia reduces the arcs rolled through, and makes ships steadier, for it shows that the unarmoured ships of small moments of inertia are by far the easiest. As to ironclads, he leaves us without any knowledge of their weights of armour or breadth of beam, though they are indispensable for even a rude estimate of their moments of inertia.

Again we ask, is it reasonable to build a great theory upon the results of one experiment? I give the contents of other tables, such as I possess, to show how little confidence can be placed in one series.

TABLE II.

At Anchor, Armoured Ships rolling.[1]	°	*At Sea, immediately after.*	°
"Northumberland"	28	"Lord Warden"	36
"Monarch"	26	"Caledonia"	50
"Prince Consort".....	13	"Topaze"	13
"Defence".....	15	"Rapid"	20
"Caledonia"	13		

Here all the easiest ships have the dangerous 5 seconds' period, while the "Northumberland" and "Monarch," of $7\frac{1}{2}$ seconds' period, stand only fifth and sixth!

TABLE III.—*June 2nd.—Squadron under Sir Thomas Symonds.*

	Roll per minute.	Mean Roll.	Maximum Inclination.	Period.
"Minotaur"	8	5·2	5·5	$7\frac{1}{2}'$
"Agincourt"	7·8	8·6	7·5	$7\frac{1}{2}$
"Northumberland"	4	6·5	7	$7\frac{1}{2}$
"Hercules".....	9	2	4·5	$6\frac{2}{3}$
"Monarch".....	6	4	5	10
"Inconstant".....	6	2·5	4	10
"Warrior"	8	10·5	16	$7\frac{1}{2}$
"Volage".....	6	11	14	10
"Captain"	7	3·6	3·7	$8\frac{1}{2}$

This table contradicts Mr. White's, as did the former, as to the ease of "Hercules," her period and stability, therefore his arguments also. If this is true, the "Hercules" has a shorter period and more stability than he assigns to her. I am disposed to think it is so. She ought, according to his theory, to roll more than this table gives her.

The equal length of period in the case of "Monarch," "Inconstant,"

[1] All armoured.

and "Volage," if this is so influential a factor as he affirms, ought to have produced an equal mean roll, if not also an equal angle of mean inclination; but the truth is, meta-centric height is not, nor can be, an influential factor, in the direction in which Mr. White argues. But let us proceed on the assumption that Mr. White's table is accurate, and ascertain what it says.

1st. That the arcs of roll of English armoured ships vary from 62° to 25°.

2nd. That the arcs of roll of French armoured ships vary only from 43° to 35°.

3rd. But the English *un*armoured ships vary from 29° to 6°.

Yet this states only half the truth, as respects the *un*armoured ships, for they are all from 1,000 tons to 5,000 tons less than the armoured ships! No doubt all these ships were not tried together, but the "Topaze" *was* tried with each squadron, and she rolled only 22°, when the best of the ironclads rolled 25°, and in this table she is credited with 22° 6′. So then it is not a "*popular fallacy*" that armoured ships roll more than *un*armoured.

But surely, the table gives the ships in the order of their meta-centric heights, agreeing with their angles of roll? By no means. The meta-centric heights of the French ships are all much greater than those of the steadiest of the English ships with long periods, and yet they are all steadier than most and nearly as steady as any but one of the English ironclads, notwithstanding that they are all much smaller, the best French ship being nearly 2,000 tons less than the best English, and 3,700 tons less than the largest; the worst French ship is 3,000 tons smaller than the best English, whose period is given as 8 seconds, while that of the French ship is only 5 seconds!

Here, again, we fail to find any law such as Mr. White would have us believe in, but quite the contrary, for, let me add, that the Admiralty report states that all the French ships were under more unfavourable circumstances than the English ships, the former having had a "heavy beam-swell" to contend against!

As Mr. White's object was to enable us to form a correct judgment upon an important national subject, we ask why he withheld from us all that was indispensable for enabling us to come to a *just* judgment?

Why strike out from the table he gave us the "Topaze?" He may say, of course, "I did so because she is not an ironclad," but he had spoken disparagingly of the unarmoured ships as compared with the armoured, therefore he should have allowed us to see what place she really took. Why omit also the French *un*armoured ships "Tour-" "ville" and "Napoleon," and the English "Edgar," if it were not that he was a special pleader for Admiralty ironclads? These were his opponents' witnesses. But why omit the English "Achilles" and "Black Prince?" which were *armoured*, and therefore ought not to have been shunted, if the whole truth was to be told. Let me bring them before you that you, Gentlemen, may hear what they say. Let us first see what further is to be obtained, as to law, from the table as it stands.

Mr. White seems to imply that there is a mysterious connection

between periodic times and angles of roll that indicates a law in connection with reducing the stiffness and increasing the moments o inertia. Yet the differences of roll for half a second of period are—

The 1st table	from 5 to $5\frac{1}{2}$ seconds	16	degrees	angle of roll.
,,	from 7 to $7\frac{1}{2}$,, ...	3	,,	,,
,,	from $7\frac{1}{2}$ to 8 ,, ...	10	,,	,,
The 2nd table	from 5 to $5\frac{1}{2}$,, ...	2	,,	,,
,,	from $5\frac{1}{2}$ to 6 ,, ...	3·7	,,	,,
,,	from 6 to $7\frac{1}{2}$, but $\frac{1}{2}$ second..	0·9	,,	,,
The 3rd table.	*No difference of period*	11	,,	,,
	From 5 to 8 seconds max.	23	,,	,,
	From to ,, min.	12	,,	,,

Nor is this all, for the best ironclad, the "Hercules," under somewhat different circumstances, rolled 20° more than the unarmoured "Raleigh," though the latter was 3,000 tons smaller, and was without the alleged soporific! taking the "Topaze" as the standard! Against "Hercules" she rolled 22°, against "Raleigh" she rolled 22·6°.

It is clear, from first to last, that there is no evidence of law, and, if anything is illustrated, it is the opposite of the law, as propounded by Mr. White, and the opposite of Mr. Froude's theory, alike demonstrating that there are elements in the problem vastly more influential than meta-centric height or moments of inertia, and that the former and neither of the latter are the causes of the differences observed.

I must now beg your attentive consideration to the contrast I shall show you by the table, as it originally stood, containing the "Topaze," placing the ships in the order of their rolling, together with other information indispensable for a true judgment, which ought to have been given previously.

TABLE IV.—*The Squadron of* 1871.

	Displacement.	Meta-centric height.	Angle of roll.	Weight of armour.	Length.	Breadth.	Period.
	Tons.		°	Tons.	Feet.	Ft. in.	
"Lord Warden"[1] ..	7,344	4·6	62	1,379	280	59	5 to $5\frac{1}{2}$
"Caledonia"	6,832	6	57	930	273	59	
"Defence"	6,070	..	49	607	280	54	
"Prince Consort" ..	6,600	6	46	941	273	59	
"Northumberland"	10,584	3·8	38	1,547	400	59 $3\frac{1}{2}$	7 to $7\frac{1}{2}$
"Minotaur"	10,234	3·8	35	1,776	400	59 $4\frac{3}{4}$	
"Hercules".....	8,677	3	25	1,481	325	50	8
"Topaze"	3,915	..	22	None	..	..	5

[1] The large amount of armour on "Lord Warden" would lower meta-centric height, as compared with "Caledonia" and "Prince Consort." She has 430 tons more armour than "Caledonia," which would raise her centre of gravity, lower her meta-centre, and reduce her meta-centric height!

Mr. White gave his table as demonstrating that weights on the sides and small meta-centric heights tend to make ships easy, and that armoured ships do not roll as heavily as unarmoured ships, and that it was a "popular fallacy" to think otherwise.

First, then, we have the unarmoured ship "Topaze" easier than the best ironclad, *though* 4,700 *tons smaller!* of a worse form for ease, no weights on her sides, and having a much *greater* meta-centric height, with a period of only *five* seconds, while the "Hercules" has an *eight* second period.

When this experiment was reported in the *Times*, it was stated, in a letter by Mr. E. J. Reed, which also appeared in that paper, that the reason why the "Topaze" rolled so much less than her majestic comrades was because her masts were much larger in proportion than theirs. Now, any one ordinarily acquainted with Mechanics knows that the increased momentum of these greater masts would carry her through larger arcs, and that, had she had smaller, she would have rolled faster, but through smaller arcs. But this is contrary to the theory that increased moments of inertia tend to make vessels more easy, which the writer was *then* contending for.

2nd. The "Lord Warden" is the most uneasy, more so than three smaller ships, being 7 feet longer than two, 500 tons larger than one, 700 tons larger than a second, and 1,200 tons larger than the third; in addition, she has, according to the new theory, a greater soporific in the shape of 450 tons more armour than two of these, and 770 tons more than the third; she has also a less meta-centric height than two of these, and *this is one cause of her inferiority!*

The "Defence" is made by this table to be more uneasy than the "Prince Consort," but Sir Spencer Robinson places the "Defence" first, no doubt correctly, as her length is greater, her breadth less, and weight of armour less.

There is little difference between "Northumberland" and "Minotaur," sister ships; what there is, is against the new theory, the more uneasy ship has 230 tons less armour, although she is 350 tons larger, and therefore ought to be easier according to *it*. As to the reason why the "Hercules" should be better than these two last, there is too little to show, except that she has a better section, if it be true that she is better? I say so, for Table III shows her period to have been $6\frac{2}{3}$ rather than 8, as given here, and rolling faster than "Agincourt," an easy sister ship of the two above-mentioned.

We need not analyze the table of French ironclads, except to state that they roll in the order of *size*, and that their *great meta-centric* heights are in favour of their *limited arcs* of roll, as compared with the English ironclads.

The maximum difference of roll between the best and worst English ironclads is 37°; the difference of meta-centric height being only $1\frac{1}{2}$ feet! while the maximum difference of roll in the French ships is only $8\frac{1}{2}$°! yet the difference of meta-centric height is 2 feet! The French ships are of the same type; the English ironclads differ essentially in many particulars, vastly more than they do in their meta-centric heights!

As to the English unarmoured ships, I have not their meta-centric heights or other general data necessary to enable me to say more than that the one ship which stands in the table as superior, is of an entirely different type from all the others, having much greater length and much greater proportionate length to breadth, which latter is the disturbing element, and she is more than 1,000 tons, or one-fourth, larger than the most uneasy; but I have no confidence in the record of "Raleigh's" rolling, as like causes produce like results, and her ordinary performances will be rather like those of "Inconstant" or "Volage," allowing for the difference of size. We shall see somewhat of the "Volage's" performances further on. We shall now give a table of the ships reported on by Sir Spencer Robinson, in the order placed by him, with additional data.[1]

TABLE V.

Name.	Displacement.	Height of meta-centric.	Length.	Breadth.
	Tons.	Feet.	Feet.	Ft. in.
"Solferino," French, armoured	6,700	4·5	290	56 8
"Tourville," „ none	5,680	5·3	240	55
"Napoleon,"[1] „ „	5,080	4·9	233	55
"Achilles,"[1] English, armoured	9,694	3·1	380	58 3½
"Magenta," French, „	6,700	5·0	290	56 8
"Edgar,"[2] English, none	5,700	4·6	240	58
"Black Prince,"[2] English, armoured	9,137	3·2	380	58 4¾
"Couronne," French, „	6,000	5·4	270	54 9
"Invincible," „ „	5,600	6·4	262	55 9
"Normandie," „ „	5,600	6·5	262	55 9

[1] Equal. [2] Equal.

1st. The two French *un*armoured ships are better than all the other ships except one, the "Solferino." She is 1,000 tons larger than one of these, 1,400 tons larger than the other, has 50 feet more length than one, and 57 feet more length than the other, with only a little more of the disturbing element—breadth. But the following is reported officially of "Solferino:"—"As to angles of oscillation, she has so "*much less advantage as the sea was heavier.*" This necessarily would be the case from the increased momentum of her armoured sides.

I may mention that, on one occasion, she rolled 5·8°, while the "Invincible" (French), rolled only 3·6°.

The "Edgar" is inferior because she has 3 feet *more* beam than the vessels of her own size; her meta-centric height is *less* than theirs also.

The "Black Prince" is only equal to the "Edgar," though 3,500 tons larger, and 140 feet longer, with the same breadth, and inferior to four other ships, the displacements of which are from 2,400 tons to 3,500

[1] Single observations are influenced by foregone conclusions, and incidental errors should be eliminated by multiplied observations. Mr. Johns, N.A., frankly told us that for a long time he could not believe that the ship he spoke of rolled 45°, and that he was still puzzled about her.

tons less. Now, how can we account for this? There is nothing in the table to show, but that she has a *less* meta-centric height, which tends to increase the arcs of roll, and the weight of armour, as compared with the unarmoured ships, which has a like effect.

The "Achilles" takes a better place than the "Black Prince," though of the same main dimensions; but the latter has 500 tons less displacement, and not so good a form below; difference of meta-centric height is inappreciable. The only thing left to account for the inferiority of "Achilles" to "Solferino," "Tourville," and "Napoleon," though she has 90 feet greater length than the first, 140 feet greater than the second, and 147 feet greater than the third, is that of her *smaller* meta-centric height, and of her *weight of armour*, as compared with none on the "Tourville" and "Napoleon."

The small size of the three remaining French ships and their armour sufficiently accounts for their inferiority, without assuming a violation of law, that it is because of their greater meta-centric heights. The "Napoleon" and "Tourville" are of a better form, besides being without armour. The "Couronne" is better than the other two, to the extent only of 3°of roll; against this, we set off her greater size, 8 feet longer and 1 foot less beam, the disturbing element.

The "Lord Warden," the worst roller amongst English ships, rolled 19° more than the worst French ship, though the former was 1,700 tons larger. This may be accounted for in part by the fact that the French ship had a greater meta-centric height by 1·9 feet.

Thus we see that the only conclusion to be drawn from the facts, figures, and opinions of Mr. White's own department are entirely against the idea that raising the centre of gravity to reduce the meta-centric height, and increasing the moments of inertia by weighting the sides, decrease the arcs of roll.

The above illustrations show that *in*stability, *not* stability, is the cause of rolling motions. I must now show that this is in accord with received principles.

It is taught that "the effort of stability is the lever by which "a wave forces a ship into motion, that if a ship were destitute of this "stability no wave that the ocean produces would serve to put her in "motion, whether that stability were due to a broad plane of flotation "or deeply-stowed ballast."

There is no foundation for this statement, for stability is the resistance which is offered to change from the vertical position; the effort of the fluid or gravity to restore the body to the rest it may have been disturbed from.

It is derived from two sources, a low position of the centre of gravity, and a broad plane of flotation.

If a vessel is inclined in smooth water both kinds will resist further inclination, or will seek to restore the vessel to the perpendicular at which she rested.

If the water-level be inclined, as in the case of a wave, that portion of the stability which is due to buoyancy will be exerted to bring the vessel's mast perpendicular to the wave surface on which she floats; in this process will be developed more and more that kind of stability

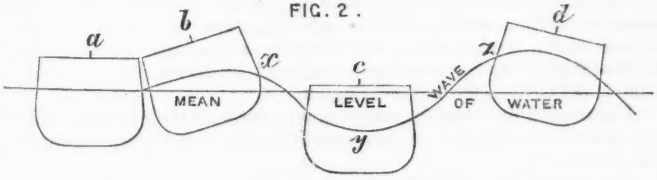
which is due to deeply-stowed ballast, or a low centre of gravity; under these circumstances the two kinds of stability are opposing, *not* concurring forces, as has been taught, one tending to bring the vessel's mast perpendicular to the wave surface, the other perpendicular to the earth actuated by the force of gravity. Therefore all calculations made on the hypothesis that stability is the cause of motion, as is done by some modern theorists, must be erroneous. Indeed these calculations are more erroneous than represented above, for they are made on a further erroneous hypothesis that the inclinations are round a comparatively fixed point in the middle longitudinal line of the ship and the rolling motions likewise!

Yet this is not true in smooth water, and is always untrue of all ships in a seaway.

The breadth is a lever through which still-water acts on a ship to produce *rest*, and also through which waves act to produce *motion*, but this is a different thing from stability, being the lever that produces motion, simply because breadth, under totally different circumstances, is an element in producing stability. Stability is an effect, not a cause!

Rolling motions of ships in a seaway are produced by the alternate rise and fall of the water supporting them, and the rise and fall of the floating body, accommodating itself to new and changed conditions, oscillates in search of, rather than possesses, stability, hence the motion. *Motion* is the result of *instability* and *rest* the result of *stability*.

FIG. 2.

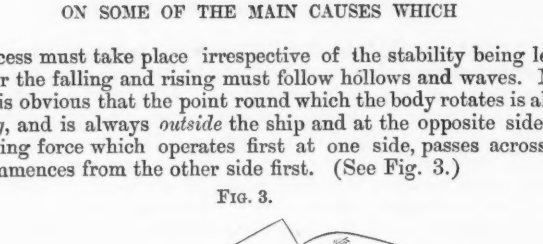


Suppose any ship floating in smooth water, as in Fig. 2, and waves to roll across her; as waves rise *above* the mean level, and the hollows fall below it, a vessel in passing over the intervening spaces must rise and fall.

Thus as the wave moves along, it will lift the side of a ship next to it, and will continue to lift and incline her at the same time until she is brought into the position of *b*; this rise and inclination will be continued till her middle line passes the crest of the wave at *x*, then her upper side will begin to lose support, and the vessel will begin to fall: in a short time this will change the direction of her inclination, and she will roll over to the other side, and will fall till the middle line reaches the bottom of the hollow at *y*; then the lower side will begin to rise and to change the direction of the roll, gradually bringing the vessel into the position of *d*, and so on, as long as the vessel is in the midst of waves, all through one side being raised first, then the middle and then the other side, and falling in the same order, and it is obvious

this process must take place irrespective of the stability being less or more, for the falling and rising must follow hollows and waves. Moreover, it is obvious that the point round which the body rotates is always *changing*, and is always *outside* the ship and at the opposite side from the moving force which operates first at one side, passes across, and then commences from the other side first. (See Fig. 3.)

FIG. 3.



A. The point of rotation when on wave face moved to the opposite side when ship is on the wave back.
A B. Mean level, and water line when upright.
A *b*. Water line when inclined on wave face.
Arrows show direction particles move in wave.
g and *g'*. Centre of gravity. *m* and *m'*. Meta-centres.
g m and *g' m'*. Meta-centric heights.

Therefore the attempt to estimate rolling motions from any power to resist inclination round a fixed axis by a lateral force, such as wind in smooth water, is misleading; and to assume an analogy between motions in the midst of waves and those produced by racing men from side to side, is delusive in the highest degree.

The motion produced by waves must vary with their height, distance apart, and the greater or less rapidity with which they move across the vessel.

Moreover the shape of the wave exercises a great and important influence; this is always changing, the face is never the same as the back of the wave, and this difference is greatly increased by the strength of the wind. The size also of every third or fourth wave varies.

Weather currents and tides are exceedingly dangerous to vessels with little stability; these make the wave exceedingly wall-like in form, so much so as to be a certain danger to vessels with high centres of gravity, as these seas would readily throw such on their beam ends.

These circumstances, the extreme ranges of draught in steam vessels, from lessened specific gravity of cargoes, and other things, involve the advocates of high centres of gravity with little stability on any pretence (and it can be no more than a pretence), in the very gravest responsibility. It is time that we were delivered from that dangerous error, that stability, especially that due to a low centre of gravity, is a cause of danger when, in truth, it is the prime element of safety—the only one that will save ships from capsizing!

A sufficiency of stability is necessary for the proper qualities of ships

as well as for safety; this is fully proved by the number of ships admittedly capsized because of its deficiency, and by the legislation as to deck-loads. Why it should be considered that stability is a cause of ships accumulating motion till they roll over, is out of all reason; indeed the promoters of this theory abandoned it when they placed from 350 to 600 tons of ballast in many ships, which they could not have done had they believed that this would eventuate in their accumulating motion till they rolled over; had any such tendency appeared in the "Sultan," they would not have added 150 to her previous 450 tons. If there was such a tendency, why is not the proof given? Is it not important?

The tendency of a low centre of gravity is to limit the arcs rolled through, and these ships are no exception. This also is established in the case of vessels laden with ore and other compact cargoes stowed low, from which their motions are so short and quick as to jerk their masts over.

As this experience is in harmony with mechanical law, those who state the opposite are bound to show when and under what circumstances the change of law takes place.

Ships for the most part are more or less like a rocking-horse set in motion, the ship and point of rotation rising and falling as the ship possesses a section of greater eccentricity, this varies with the proportion of half breadth to depth—a circular, cross section immersed to its axis is the easiest form.

The Bessemer scheme never could have succeeded because of this vertical motion, but to have put the machinery into a form of the extremest eccentricity, as was done, was to guarantee the completest failure.

As this modern theory does not recognise these indisputable facts, but jumbles up wave-motion and independent motions with extremely divergent elements in one ship as compared with another, that any one should accept it as true is really astounding.

Let us examine more closely this theory of accumulation for which so many important properties in ships are sacrificed.

It is said that a ship's roll in still-water produced by men racing from one side to the other, if repeated, will so increase her angular motion that she will be rolled over, also that if a ship have a short period of roll, her motions will synchronise with those of the waves in which she floats, and that thence she would have her motions so increased that she would be rolled over.

It is also said that if a vessel's stability be great, she will have a short period, and thus be liable to be rolled over; the greater the stability the greater this liability, so that stability would be a continual source of danger. To prevent this, it has been recommended and largely carried into effect to raise all the centres of gravity, and to increase the weight on and at the sides to lengthen their periods of roll.

Is there any justification for this course? None. Let us revert to the still-water process of rolling.

Suppose all the crew of one of our ironclads to be placed on one side, then raced across to the other, backwards and forwards frequently. If

the men wait until the roll is completed, a further impulse will be given each time they race across, and therefore the angle of roll will be increased, but the men must wait till each half roll is completed. As a consequence, the time of the first complete roll will be less than that of the second, and third, &c.; then if the vessel's cross section is that of an eccentric wheel the centre of gravity will rise, and in its fall back will accelerate the motion, and tend to increase the angle of roll and alter the period. Consequently the period will alter with the form of the ship and with the number of rolls, irrespective of metacentric height, and will not be the same for the angle of roll of any ship.

This is the case of a ship rolled by a force from *within*, and its time must be exactly adjusted each roll, or there will not be any increase of angular motion.

There is no inherent power in a ship to roll; she remains at rest till disturbed; how, then, compare a ship's period in still-water with her period in the midst of waves?

At sea the rolling motions are produced by waves and *without* the ship, which take the place of that of moving the centre of gravity from one side of the middle line to the other.

How, then, can there be a synchronism between the wave-period and that which has no existence, for the centre of gravity is not moved at sea as in still-water?

All motions in a seaway are produced by wind or water; if the former does not operate, then waves are the sole cause of the motion. If the wave motion ceased, the ship would come to rest.

No doubt according to the form and disposition of weights, a ship will be more or less free to yield herself up to wave motion.

If a ship takes the motion of the wave, there can be no synchronism of motions, for there will be but one, commenced with one wave, terminating with the next. But no ship can take completely the wave-motion, because of her greater inertia than that of the water, and because there are always cross-waves and wavelets, as Captain Maclear observed, "not in one case in a hundred that you find regular waves; "they are always confused; there appear to be waves coming in all "directions, or one set overlapping the other, so that the greatest "difficulty is experienced in finding out what you actually observe "when trying to note the true crests."

Clearly no synchronism, such as is supposed by this impracticable theory can arise, for it requires a succession of waves to follow each other with great exactness of time, of size and form, to fit exactly with a ship's supposed independent motions and ever-changing rolls as every cross-wave and wavelet alters, in their measure, the ship's motions destroying the chance of synchronism, as a rule, and yet for the accumulation of angular motion a rule of great exactness is indispensable.

The floating body that will most nearly accept the wave-motion is a raft, wholly but not deeply immersed, and with the smallest inertia; next in order a stage, then circular ships of small draught; lastly, all other things being equal, the ship whose plane of flotation is greatest.

To compare ships' motions on the simple grounds of their meta-centric heights is most erroneous; for suppose a ship's cross section to be circular, and she immersed to the axis, her centre of gravity below this, also plastic, so that we can alter her form without change of cubic contents or weight, and her breadth to length as 1 to 4, and to be upright.

If a wave now roll up to her, according to its form and velocity, there will be more or less of lateral impact, together with a lifting force acting at the side nearest to it, which will incline her according to the inclination of the wave face on which she floats, and in the direction in which the wave and its particles *above* are moving, and this inclination will increase as the wave-centre passes on and across her, and until the centre has passed the ship's middle line, after which it will continue to lift her, but acting on the other side will tend to overcome the original motion before rolling her back.

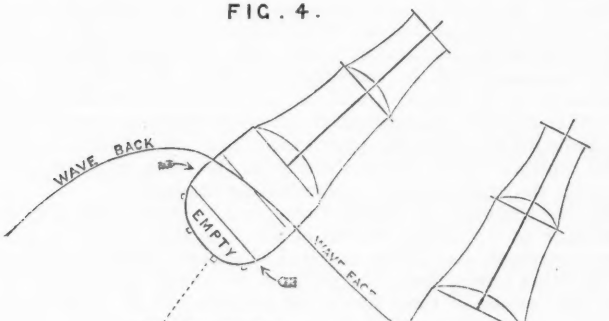
As the tendency of smooth water was to retain the ship perpendicular to its surface, so that of the wave is to force the ship to take a perpendicular to the new and changing surface, and were it not for other forces, that is the position she would take from time to time, but because of these forces, her position will be a resultant of these together with that of the wave-force. Consequently a ship's period could not commence with, nor terminate with the wave-period.

What then are the differences and what their causes? 1st. Besides the lateral impact and lifting motion that inclines her there is the motion of the upper particles moving *rapidly* in the same direction as the wave tending to push her over further than the perpendicular to the wave-face, then the particles *below* moving in the opposite direction, tending to push her keel or lower part with them, consequently these two acting as a "*couple*" incline her still further, nor is this all, for the ship floating on an inclined surface gravitates down it, at the same time that she is lifted over, and forced down it by the wave-motion and the fast moving particles *above*, if under the pressure of sail so much more so, then the water *below* resists both, because the particles there move in an opposite direction, and because the great pressure under which water deep down is, it cannot be displaced with anything like the rapidity of that *above*, all which tends to carry the vessel beyond a perpendicular to the wave face; in this case bilge-keels will only aggravate the incline, as they would tend to hold the keel or lower parts from slipping down the incline while the upper parts did so, all which would lengthen the period, consequently no ship can possibly take the wave-motion in the first half of the roll.

We have now to consider the back-half of the roll. The instant the centre of the wave has passed the middle-line of the vessel, its tendency is to lift the lower side, thus to arrest the forward action of the inclining forces, the loss of water-support from the upper side, and the gradual descent of the vessel into the hollow, also tend to change the direction of the roll; but because the forward motions of the particles *above* continue for a time to press her forward, and those *below* to press the lower parts in the opposite direction, the moments of inertia not being immediately overcome and given an opposite

direction to, the roll on to the back of the wave is never so great as that on its face; this difference is greater because the slope of the back is never so great as that of the face, more particularly in strong winds—for these reasons also the ship's roll cannot terminate with that of the wave.

FIG. 4.



We have now to consider what are the other causes which influence the extent of the roll that must inevitably take place.

We start with a given wave as to form, size, and velocity, and a ship of a given form and size.

Such will more readily and more nearly accept the wave-motion as her proportionate breadth to length is greater because this breadth will afford greater leverage to roll her over, and because the wave will be a longer time passing to her middle line, and so would be a longer time operating in lifting and inclining her, therefore her roll would be through larger arcs.

She will more readily accept wave-motion as the centre of gravity is higher.

She will accept more of the wave-motion as her immersion is less.

And in high seas, though more difficult to move in smooth water, and at first, once set in motion, the greater her moments of inertia, the greater will be her arcs of roll.

On the contrary, all other things being equal, the greater the size, the greater the immersion in undisturbed water below wave-motion, the greater also her immobility, therefore the less her motion in waves of a given height and force.

Also the lower the centre of gravity, the more it will resist inclination or rolling motions; for the lower it is, the further it will require to be moved out from the perpendicular at each increased angle of roll, therefore the greater must be the amount of work done in resisting

inclination and in limiitng the extent of the roll, and as its tendency is to bring the vessel back from the roll forward, the more certainly it lessens the chance of synchronism.

If we now suppose the ship drawn out till her breadth to length is as 1 to 5, and the centre of gravity lowered to preserve the same stability as before, and her depth the same, the wave will have a shorter lever to lift her by, and it will be a shorter time operating to lift and to incline her, so she will not be carried so far over.

Then the centre of gravity being lower it will tend to limit the arcs of roll both to one side and the other.

The moments of inertia in a narrow ship, similarly arranged, will also be less, which, especially in high seas, will be favourable to small arcs of roll, this was observable in the "Solferino's" losing her place in rough weather, and more so as the weather was rougher, as compared with smaller and unarmoured ships. The greater length also tends to resist motion, so the long, narrow, ship has decided advantages in a seaway over a shorter, with a higher centre of gravity.

It will be sufficient notice of the pegtop shape to mention that the old "Albion" of that form of the same length and depth of immersion as the old "Rodney" rolled through 47° and 13 times while the "Rodney" rolled only 29° and 8 times, their stabilites, as estimated by inclination under sail or by calculation differed but little. The period of the latter was about 7 seconds, that of the "Albion" little over $4\frac{1}{2}$ seconds; therefore, meta-centric height will not account for the differences in this angle of roll or its rapidity.

The "Rodney's" centre of gravity was lower and her moments of inertia less, so according to Mr. Froude's theory she should have rolled more deeply than the "Albion."

What then is the explanation of these enormous differences? 1st, greater breadth by 6 feet; 2nd, higher centre of gravity; 3rd, greater moments of inertia, and 4th, her pegtop form.[1]

Again, it is contended not only that there is no chance of a vessel with a long period rolling over, but also that such will scarcely roll at all.

How then, we ask, account for the large angles of roll of the following vessels, all with long periods?

"Hercules"	8 seconds	25°
"Monarch"	$7\frac{1}{2}$ „	37°
"Agincourt"	$7\frac{1}{2}$ „	26°
"Devastation"	$6\frac{3}{4}$ „	26·30°

These last two are reported to have rolled through some extraordinarily large angles which are not recorded. But why? Since these are the dangerous rolls from which these long periods have not saved them, and in these would be found the proof of accumulation of

[1] The meta-centric height of these ships being equal, the extraordinary difference in range and rapidity of roll must have been due to her cross section, making her into an eccentric wheel that no disposition of weight could alter—to raise weight would be to increase angle of roll already too great, to lower weight would be to increase the rapidity already too rapid.

roll had it any existence, why is the proof, whatever it was, withheld?

Again, the—

"Crocodile"	.....		40°
"Northumberland"	.....	$7\frac{1}{2}$ seconds	38°
"Minotaur"	.....	$7\frac{1}{2}$ „	35°
"Volage"	.....	10 „	53°

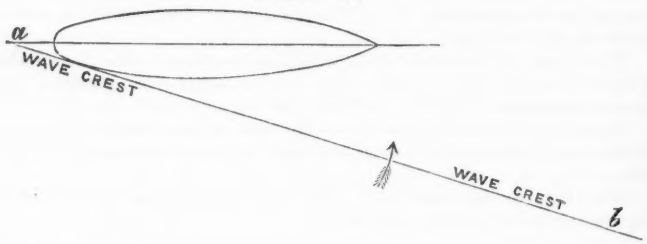
Period deduced from Table III:—

Mr. Johns' vessel	.....	10 „	58°

In no one of these cases is there any evidence that these large angles were the result of accumulation, and when Mr. White informs us that the "Devastation's" angle of roll was doubled by her steering a course that shortened the wave period and not her own at the same time, this more certainly precluded the possibility of synchronism.

The reason of the "Devastation's" increased angle of roll could not have been by accumulation, as he shows himself, it was because the oblique course she steered with reference to the wave ridge, or crest, kept her longer under the influence of the wave motion than when she had her broadside parallel to the wave, which was like adding to her breadth; this would occur to any vessel irrespective of her meta-centric height or period, but would operate to a greater degree on a ship with little stability or small meta-centric height. Herein is the danger to such vessels.

FIG. 5.



Suppose *a b*, Fig. 5, to represent the crest of the wave moving in the direction of the arrows, if the stability is little, a short length of the wave will incline the ship, and will incline her more, as more of it reaches her side, the extent of the roll will be increased as the centre of gravity is high, and the bottom empty, the fast moving particles above pushing her over together with the wave, and the slow moving particles *below* pushing the lower parts in the opposite direction. She meanwhile is a longer time slipping down the incline of the wave face, tripped up by her keel and bilge keels, and most so when the bottom is empty, which therefore *easily yields* to this double pressure on it.[1]

Indeed, Mr. White's explanation is an abandonment of the whole

[1] Fig. 5 supposes the ship moving obliquely *with* the wave, if not going fast, she

principle, for he asserts that the course the "Devastation" steered, and the rate she moved at, were the causes of her increased angle of roll, and *not* her less meta-centric height or changed period.

Were there any truth in his explanation then ships with registered angles of 50° or 60° would have the wave-period shortened to them, and their angles of roll doubled; I am sure Mr. White would not accept this logical issue of his explanation.

The Scientific Committee who accepted this long-period theory, recommended an increase of beam; it is difficult to understand with what consistency, for an increase of beam involves shorter periods and quicker, as such ships accept more of the wave-motion! This they were sensible of, and recommended the use of bilge-keels, the tendency of which, according to their own showing, is further to shorten the ship's period, in other words they adjust these periods so that the vessels may have the full benefit of accumulation, and its dangers, if any.

Mr. White contends for the existence of a law while he gives abundant reasons why it cannot exist; thus he says, "No ship "exactly fulfils the conditions in the direction and magnitude of the "fluid pressures. The importance and extent of these variations depend "upon many circumstances, the form, the *magnitude of the ship*, her "course, and speed relatively to the waves; the dimensions of the "waves, the proportionate height to length," &c., and yet without reference to, or any estimate of these and other influential elements in the problem, he affects to have demonstrated the law of change and shown it to be entirely due to meta-centric height and moments of inertia!

What I had supposed law to be, was a rule or sequence of known facts, or forces, or quantities, but here the known quantities are eliminated, and the value of an unknown quantity is sought in terms of other unknown quantities. So far from there being any law, such as is supposed, and safety from applying long periods, these have increased the danger of capsizing by the action of the second wave synchronising with the motion produced by the first wave.

Is there no case of synchronism when the motion of the wave concurs with that of the ship to roll her over?

Certainly! but it occurs when the period is long, with little stability from a high centre of gravity, for then the ship is easily rolled far by one wave, and is without power to return to little more than the upright position, when a second wave catches her; if pressed by sail and is on the face of a steep wave, she will be rolled over.

This was the case of the "Captain," from which a higher side would not have saved her, since she was not so much rolled round a central point *within* her as round one *outside* her, and at one side,

will be long on the face of the wave, longer subject to its inclining force, liable to broach to and be rolled over if stability be small; she will not so early meet second wave.

If she steer to meet the wave, obliquely, she will be a shorter time under its influence and will meet second wave sooner, and shorten the period. If her course is sufficiently oblique she will have the benefit of some longitudinal stability and safety in proportion, hence the value of bringing one bow to the sea!

which lifted her up and pushed her over, facilitated by her slipping down the steep incline of the wave face, while pressed down by sail. She was also tripped up by the resistance and motion of the particles *below*, pressing in the opposite direction on her *empty* bottom which readily yielded to this pressure, so found its way to the surface, and whilst her heavy top-sides found their way down, the saved men getting out on her bottom. She had a long period—10 seconds!

This also was the case of the ship mentioned by Mr. Johns, N.A., only she escaped from not being under sail. He described two ships, in every respect, their lines, "their weights and distribution the same, "yet one behaved moderately well, the other abominably."

He adds, "After two or three weeks of rough weather there was no "question of the fact that the (latter) vessel had rolled 45° to leeward "and 13° to windward.

These observations were made with pendulum and batten.

This ship's period was double that of the wave, and yet, contrary to Mr. Froude's theory, "she rolled from the crest of the wave."

Mr. Froude's statement of the principle is, that "*if a vessel were* "*without stability, whether that stability were due to a broad plane of* "*flotation or deeply-stored ballast, the highest wave would fail to roll* "*her*," or, in other words, as given by Dr. Woolley, "*therefore every* "*ship to be safe ought to have a very considerable period; and in order* "*to that she must have very little initial stability.*"

Mr. John further said of the ship, that she rolled on her side, rolled quickly, and that her period was double that of the wave, and that the wind could have inclined her only 2°.

Her rolling on her side is evident from her rolling 45° one way and only 13° the other.

Her rolling quickly seems a contradiction to the statement as to her long period, it may have been true, however, as to the first half of her roll, that forward, as she was then under so much pressure.

It is obvious that her stability was little.

How then account for her rolling on her side?

Having little stability, a steep-faced wave partly by impact and by its lifting power would raise one side first, then continuously aided by the wind and the fast-moving particles going in the same direction, would carry her beyond a perpendicular to the wave-face, she would gravitate down this steep face, while the particles *below* moving in the opposite direction would trip her up, all together, forcing her to roll from the wave crest.

Then the moments of her masts, she being light, and her moving to leeward with greater velocity, would tend to increase her roll to leeward by their increased momentum. The rolling back only 14° would arise from a high centre of gravity, thence little power to return, the particles *above* and those *below* would oppose for a time and the moments of her masts would not be overcome so early as those of the ship, her period being double that of the wave, she would have made only half her roll when the next wave would catch her at the upright position, and roll her over on her side again, so we have little less than a synchronism, because her period is *too* long *not* too short!

An increase of wind, or velocity, or size of wave, would have rolled this vessel over, thanks to her long period! We ask of what use could sails be to such a ship in such a condition?

This also is the explanation of the alarming condition reported of Her Majesty's ship "Volage," rolling 35° to leeward and 18° to windward, shipping green seas that washed men over her guns,—she also had so little stability that she inclined 14° when other ships inclined only 6° or 7° (see Table III), yet she was one of those ships that had been ballasted, but not sufficiently. The charge brought against her captain of not putting more sail on her is preposterous, since she had then too much; more would have proved fatal.

Here we have a 2,000 ton ship in danger, while the 500 ton storeship, with sufficient stability, was quite safe.

The proper explanation of the "Volage's" rolling 10° each way in a nearly glassy sea, and after bilge-pieces had been given her, and the "Dreadnought" rolling much at one time and not at another, was their little stability; so a passing wave of considerable velocity set them rolling, and not the principle of accumulation. If that were true then a long period affords no safety, for these ships had that.

The effects of solitary waves may be seen every day, and many times on the Thames. They arise from waves thrown off from the paddles of powerful steamers passing across vessel's paths, and disturb the light and high centred vessels easiest and to the greatest extent.

The Wreck Register contains abundant evidence condemnatory of little stability, and its evil effects.

The "Princess Alice" was turned over when rolling deeply.

She had a large amount of empty ballast tanks.

The "Alice" was lost because of little stability; she also had 200 tons of empty tanks.

The "Thornby," 1,400 tons, was lost through diminished stability; she had 250 tons of empty ballast tanks.

The "J. R. Rea" was thrown on her beam-ends and lost.

The "Perseverance" was thrown on her beam-ends and lost.

The "Southern Empire," 1,500 tons, likewise.

The "William Lindsay," three days out, was thrown on beam-ends, and was lost.

The "Violet," crank, laboured heavily.

The "Stuart Hahnemann," 2,500 tons, capsized; heeled over gradually in fine weather, and foundered.

The "Tacna," capsized in fine weather, in the act of turning her head in for her port.

The "Great Britain," 880 tons, capsized, masts cut away, *righted.*

The "Sarpedon," thrown on beam ends; when mast and deck-load went, she righted.

The "Eastern" lay over half under water; when masts and deck-load were got rid of, she righted.

The "Western Empire," on beam ends; when masts and deck-load were got rid of, ship righted.

The "Broderik Castle," too stiff; dismasted, but ship and crew saved.

The "Lady Louisa," too stiff; dismasted, but ship and crew saved.

Of the large number of missing vessels 100, with 1,000 lives, many would afford like testimony did we know the history of their disasters, much of their deficiencies would have been from "over-loading," or "light cargoes," without sufficient ballast, as the "Stuart Hahnemann," or shifted cargoes, or *free-water* in the hold from leaks.

I have shown that the so-called scientific theory affirmed by great names, in virtue of which sailors are required to stand upon their heads or to sit to be indoctrinated in it, has no foundation in sense or science (which is experience reduced to rule), not theories elaborated in the closet out of imagined facts.

Sailors have been in the habit in bad weather of getting down all top-hamper, housing main-deck guns, &c.; this was thought right in the dark ages, when it was thought that Nelson, Collingwood, and Exmouth were men of sense and sailors; in the name of science, we are told this must be reversed, the more deeply a ship rolls, and the greater the danger of rolling over, the more her centre of gravity is to be raised and deck loads encouraged with that view, and empty spaces below enlarged!

Arising out of this course, we have the anomaly of sailing ships that are unable to sail, or be steered or managed with their safety, or with that of other crews.

Captain May reported that the "Northumberland," of 10,000 tons, when caught in a heavy gale, should, if possible, steam at slow speed; the square sails should then be furled, the after trysail set, and the ship's head placed with the sea three points on the bow. This is the position in which the roll of the "Devastation" was doubled—so it appears Captain May gives a choice of evils.

Lord Guilford, speaking of the "Hercules," 8,700 tons, said, "She "steered so wildly, and broached to so often, that he gave up the "idea of running out of the gale, and hove to, with trysails, *using* "*steam*."

Sir Sydney Dacres, after considerable experience said, that though there was great advantage in the power of a masted ironclad to keep an assigned station in the open sea without using coals, it was not possible, masts or no masts, to do it in the Channel. He could not call ironclads sailing ships at all; "there was no sailing in them."

Sir Thomas Symonds "doubted the possibility of a ship displacing "9,000 tons, sailing well, even with a lifting screw; sails could scarcely be given her of proportionate size."

The "Penelope" was reported as always sailing on her side, though with reduced masts and sails, and rolled 30° each way or 60°. We may here ask Mr. White what unarmoured ship rolled this amount?

Sir T. Symonds reported against both the "Captain" and "Monarch," as steered with difficulty, the latter as taking sometimes an hour to wear, and attributed it rightly to their want of stability.

It was reported officially that the "Inconstant" would not stay without steam.

"Eclipse" was "*crank*" and an "*incurable roller*." "Bellero-"phon," Captain Wells said, "lay like a log on the water when

"hove to; that, if there was plenty of wind and the sea suited, she "could be kept on her course; but it was difficult to keep her off the "wind if the sea did not suit her; her after sails were of no use in "keeping her to the wind; but, on the contrary, had to be set to wear "the ship, under sail alone she was unmanageable, and more un-"manageable in strong than light winds."

This is the necessary consequence of insufficient stability. Similar unmanageableness, not to this unparalleled extent, is manifested in vessels of the Mercantile Marine when they have small stability. The marvel is, not that there are so many collisions and other accidents, but that there are not more!

In conclusion, we remark, that of the vast number of vessels that we have a record of, not one appears to have been rolled over because of having too much stability, while numbers are clearly lost every year from having too little, a further demonstration that the theory of rolling over by accumulation from synchronism, is without foundation.

A very large proportion of those lost, were vessels with cargoes liable to shift when the vessels are rolling, or by lee-lurching; and evidence is given that their cargoes did shift, evidence also is frequently given that when they are relieved of their masts or deck-cargo, they have righted sometimes too late as they have shipped too much water; this clearly establishes that they were deficient in stability.

There have been a few cases recorded where the stability was too great; in these cases, the masts have been rolled away, but the ships and crews have been saved, yet according to the Froude-Reed theory, these ships should have been rolled over.

It will now be said, apply what you have stated to "Inflexible."

I have not sufficient detail about her to say whether she is safe or not, but I can say confidently, that she is the legitimate offspring of the system I denounced on the occasion of the loss of the "Captain," for which Mr. E. J. Reed is responsible for introducing it into the Navy.

But if the "Inflexible" is unsafe, what must be the condition of the fleet of ships of the ricketty family *more* deficient of stability? Those without armour, pervious to every shot, and those with thin armour, that can be perforated like brown paper by a candle shot. Such from shot holes, from leaks and hurricanes, would appear amongst the missing ships without any detail of their disaster!

There is one ray of comfort in this controversy, arising from the fact that the original combatants who had all argued that, for safety, ships must have "*very little initial stability*," are now abandoning that erroneous crudity, and are seemingly racing to see who shall give most stability, but no doubt in the worst form!

Neither party in the combat, however, have taken a safe basis from which to estimate the safety or otherwise of "Inflexible."

Estimates founded on still-water periods or still-water performances give no reliable data for determining motions or dangers in the midst of waves, for the motions of ships in still water and those produced by waves, as the moving forces in the latter case, their number, direction, and effects are so entirely different from those in the former.

In the first case, the motion of the centre of gravity is the disturbing force which is moved horizontally; the forces turning the body are vertical, any lateral action is confined to the resistance of the water to the vessel's rotation, while the inertia is common to both in one phase, but in the latter it obtains in two forms.

In the second case, the moving force proceeds from *without*, and though the centre of gravity is moved vertically, together with the whole body, it is in no degree a moving force, which alone proceeds from the waves; then, besides the vertical forces lifting, lowering, and inclining her withal, there are the lateral forces of the particles above and below acting as a *couple* to rotate her, together with the tripping force as she slips down one face of the wave or the other, of which sailors are sometimes made intensely sensible, by the suddenness of *arrest*, and the depth of the lee-lurch.[1] (See Fig. 4.)

And lastly, in the first case, the vessel is rotated round a comparatively central point *within* her, which is moved but little, while in the second case, she also rotates round a point *without*, and at the opposite side to the moving force. This point changes from that side to the other when the forward roll is completed, and she begins to roll back, precluding the possibility of correct estimates by the method used for the "Inflexible." Thus only three moving forces are mentioned as obtaining in the problem, whereas there are six or more.

The Committee recommend (substantially) an addition of 10 feet to the beam of new ships in order to double their stability; this implies a doubt of the sufficiency of that of the "Inflexible." The effect of this increase will be to make them deeper and more dangerous rollers, to prevent which they propose deep bilge keels; the action of both these plans is to decrease the period, and give the ships the full benefit of the dangers of accumulation, if they exist. Thus the Froude-Reed theory is given up, which surely had better be done frankly, that the country may benefit by its open repudiation, than that it should be done by a side-wind.

The untrustworthiness of the meta-centric heights may be gathered from the fact that the "Invincible," with 2 feet meta-centric height inclined 17° without any sail, and yet the French "Ocean" class carry all sail without any ballast, and yet have only the same 2 feet, the difference being that the 2 feet is measured up in the "Invincible" from a *high* centre, in the "Ocean" from a *low* centre of gravity. In theory, as taught, this may not make much difference, but in practice it makes equal, at least, to the 340 tons of ballast placed in the "Invincible" to make her stand up, introduced after proof of the danger of her upsetting.

Again, the "Penelope" sails on her side, yet she has 3·5 feet of meta-centric height, while the French "Richelieu" has only 1·5 feet, and we do not hear of any complaint of her danger. The "Monarch" and "Eclipse" are unable to use their guns if only run out on one side.

[1] All sailors know that ships come down so suddenly into the hollow with the lee-lurch, as to shoot a wave from the side like a wave from the bow when going 10 or 12 knots.

These differences invalidate the present system of calculations and destroy all reasonable confidence in meta-centric height estimates, and are due to the fact that in some of our ships the weights are lifted 4 or 5 feet off the bottom in search of a deck-load on the plea "*to check rolling*." (See Lecture by Mr. E. J. Reed on "Captain," at the Royal Institution.)

The "Captain" was designed to have had 4·6 feet of meta-centric height, less than enough with her empty bottom, yet had she not been received into the service with only 2·6 feet, we should have had her 500 men still amongst us!

I observe that the Committee on the "Inflexible" lay great stress on the effect of *free* water in her hold if she is damaged, in reducing, as they say, the arcs of roll. This is a most perilous idea to set afloat without explanation and caution, as it will lead men to think that it is advantageous not to pump ships quite out. Now, the effect of this free water in smooth-water-rolling may tend to reduce the arc of roll; but this cannot be the case in a seaway, for as it rolls to leeward with the lee-lurch, like shifted cargo it will tend to throw ships on their beam-ends; if at first it does not do that, it will retard her return to the perpendicular, thence the next wave will roll her further to leeward, and will exaggerate the roll, if it does not help her over.

I do not think anyone can calmly consider the records in the "Wreck Register" and not be assured that the effect of this free water from leaks is to reduce the stability; to give ships a permanent list; to render them unmanageable; and finally to lead to their being thrown on their beam-ends and foundering.

It ought not to be overlooked that the "Conqueror," a fine 90-gun ship of 3,000 tons displacement, was thrown and blown conjointly on her beam-ends without having a stitch of sail set, and was only saved by her swinging round, the sea taking her on the opposite side, set her up; yet she had a meta-centric height of 4·6 feet. What, we ask, could happen to such vessels as the "Monarch," "Inconstant," "Raleigh," or "Volage," if damaged, leaky, or if caught in a hurricane with stabilities represented by 2·2 feet up to 3 feet, reduced to 1·5 and 2 feet when coals and stores were consumed?

When the "Invincible" and her class proved so deficient in stability as to require 340 tons of ballast, Mr. Froude said that it was for the purpose of placing her centre of gravity where it was intended to have been; therefore we have a right to ask, what proof is there that the centre of gravity of the "Inflexible" is in the place it was intended to be?

What proof is there that the centre of gravity is where he supposes it to be when cutting her down to within an inch of her life, leaving no margin to cover these errors?

The cases given may be taken as typical of all that founder.

What is the remedy?

1. There should be a full public repudiation of the disastrous *no*-stability theory, and Architects should be held responsible for the lives lost through its use.

2. It should be authoritatively stated that nothing will compensate for a sufficiently low centre of gravity; for weight on the floors, and the less the proportionate breadth to length, the lower this centre should be.

3. All vessels of war, transport, &c., with little stability, should have this increased by ballast or by lowering the centre of gravity otherwise, to increase their efficiency and safety; and all new ships should have their centres of gravity as low as in former good and safe ships—such, for instance, as the old "Trafalgar" of three decks.

4. All vessels carrying light cargoes, including wood of most kinds, should be compelled to carry ballast; a fixed quantity for every 20 tons of goods proportioned to its small specific gravity, unless they have a sufficient quantity of iron or ore as part cargo stowed low down.

5. Some better method of determining what ought to be the maximum immersion should be devised—painting a water-line is a deceptive farce.

6. All vessels carrying cargoes liable to shift, such as corn, seed, rice, coals, and even wood, should be obliged to have two perpendicular fore and aft bulkheads carried up as high as possible; these, while they would secure the cargoes from shifting, would so strengthen the ships, making them into hollow girders, and distribute the strain from the bottom, and would effectively strengthen long narrow ships, so that ships would be far less subject to leaks and to disaster, and the cargoes would be less damaged in transit. I need hardly say it would effect a great saving of life. In fact, everyone would reap a benefit from such.

It appears to me that there is an idea current amongst many that vessels with heavy cargoes, including coals, may be loaded to any amount they can carry in harbour, without any more danger at sea. This is a fallacy that ought to be exposed. Three inches of freeboard are too little for every foot of immersion, more particularly when the proportionate breadth to length is great. It is absurd to make no difference in this allowance where the proportionate breadth is great!

Some statements of Mr. White require special mention and inquiry. Notwithstanding the upsetting of the "Captain" from insufficient stability, the risk run by the "Invincible," and the deficiency in this respect of all her class, the "Sultan" and her class, and others, the supply of great quantities of ballast and reduction of sail in many cases, to make the ships safe, he says that the designer had no misgivings, and even that it was by *design* that greater stability was not given!

We ask, was it not by *design*, and with the concurrence of the Constructive Department that all this ballast was placed in these ships? Was it not by *design* that their sails were reduced?

For Mr. White says of this modern theory that led to this extraordinary reduction of stability:—"The highest authorities in this "country, in France, in Italy, and elsewhere, are unanimous in their "acceptance of its principles." Then, were the *designs* correct, and the alterations made in order to insure utility and safety erroneous?

This language is all the more remarkable, as Mr. White teaches that every ship to be safe ought to have very little initial stability.

I may, as on the occasion of my lecture here, on the loss of the "Cap-"tain," be charged with producing alarm in the minds of sailors. I am free to confess that I felt it my duty to incur that responsibility in 1870, prior to trials, subsequent to which many ships have been largely ballasted and fully justified my warnings. And in the face of the melancholy fact that 1,000 lives were lost in 1876 in 100 ships missing from deficient stability in design, from deck-loads, or from overloading, &c., with my strong conviction on the subject, I should feel that I was wanting in humanity did I not protest in the strongest terms against the doctrine by whomsoever propounded—"that in "order to *be safe, ships should have* VERY LITTLE INITIAL STABILITY;" in other words, they *should be difficult to steer, should be unable to carry sail, and should be easily upset!*

Mr. WHITE, Assistant-Constructor, Admiralty: I must apologize first of all for being unable to attend the whole reading of the paper. I must also thank Admiral Fishbourne for his courtesy in sending me a copy of that paper. My copy, however, did not contain the concluding sentences just read. He is fearful whether ships are to be built which are to consign hundreds of our gallant seamen to a watery grave. He seems to think I am in favour of building ships with no stability; but I think I shall be able to show that this is quite a mistake. Permit me to read one passage from my paper which will be quite sufficient answer to this. It is this:—"Enlarged expe-"rience with bilge-keels has proved that these appendages may be trusted to limit "the rolling of ships, having a moderate but sufficient amount of stiffness, and to "place them on terms of equality as to steadiness with cranker ships having less "powerful bilge-keels. With this experience as a guide for naval architects, there "is no probability that the stiffness of future ships will be diminished to the same "extent as it is in some existing ships designed before the steadying effect of bilge-"keels was so well established." I am one of the last to wish to deprecate fair criticism, but I think when quotations are made from one part of a paper there should be also fair quotations from other parts. The copy of Admiral Fishbourne's paper which I had the pleasure of receiving did not contain any remarks such as those with which Admiral Fishbourne concluded, so that I am not prepared in the same way to answer them. But let me take up in succession just a few of the more important points in that paper, more particularly as it affects a criticism of my own. From my previous acquaintance with Admiral Fishbourne's writings on naval architecture, I was perfectly prepared to find that he did not agree with my belief in the soundness of the modern theory. I may add I do not expect anything I can say here to-day will convince Admiral Fishbourne; my great desire is to make clear what was the meaning of my paper, as it seems in some points to have been misapprehended by Admiral Fishbourne. The soundness of this modern theory is one important point. Admiral Fishbourne repeatedly says that the modern theory gives the "go-by" to accepted principles, dynamically and hydrostatically. He says it is mathematically unsound. What is the answer to that? The answer is, that men of the eminence of Sir William Thomson, Professor Rankine, the Professors in the French Naval School, men of the highest standing as mathematicians, the leading Italian naval architects, and others I might name—mathematicians as well as naval architects—without an exception accept the mathematical soundness of this theory. Admiral Fishbourne has taken upon himself, as an authority on this subject, to say that this theory is mathematically unsound. I mention these authorities and do not put my own opinion against his. I believe I am right in saying also that Mr. Scott Russell has expressed his concurrence with the general principles of the theory; but from the "Transactions" of the Institution of Naval Architects you can gather undoubtedly that Professor Rankine and Sir William Thomson and others are in favour of the mathematical soundness of the theory. So much for that. Next, as to the

agreement of the deductions from this theory with fact. In my previous paper I gave a few examples of one department of the subject. My paper was simply intended to put before this Institution briefly a few of the broad practical deductions from the modern theory. One of those deductions is this: if a ship is set moving in still water by any means, and then is allowed to move freely, the time she occupies in swinging, from out to out, would be called the "still-water period." I find that "period" is a term used by Admiral Fishbourne in many senses in the course of his paper; but I am speaking of the "still-water period" in my table which Admiral Fishbourne quotes. The longer that still-water period is, the steadier, as a rule, should the ship be at sea. On the whole, I said this would hold good, not always. I do not expect any ship to always stand up and let the waves roll under her. This deduction from theory, I say, is supported not merely by the figures I gave, but by Admiral Fishbourne's own tables. But then I said further—and this is what I want to notice most carefully—I said that in the still-water period there were included the effects both of differences in meta-centric height and in the distribution of weights which influenced the moments of inertia. When I speak of period, therefore, I am including both those things. Thirdly, I said—and of this Admiral Fishbourne has taken no notice whatever, although from the passage I have just read it is one upon which I dwelt most prominently—that the addition of bilge-keels had a most important effect upon the behaviour of a ship, as to the amount of disturbance she made in the water as she rolled about. I believe I am not doing injustice to Admiral Fishbourne when I say he does not in the least apprehend the importance I attach to that aspect of the question. I only find him criticising remarks on the meta-centric height.

Admiral FISHBOURNE: I let you speak for yourself.

Mr. WHITE: I have carefully read Admiral Fishbourne's paper, but in my own copy I do not find prominence given to my remarks on bilge-keels. Now, coming to Admiral Fishbourne's tables. Admiral Fishbourne objects to my tables as incomplete. They were not put forward as complete, and purposely so. But I have now to refer to his tables, and to try to prove my case, which may be stated as follows:—The *longer* the period of a ship, the *steadier* she will be on the whole. Take Table IV, in which there are several ships having a period of 5 to 5½ seconds. The ships are placed in the order of their rolling. Leaving out the "Topaze," and taking the ironclads, I will ask you to notice whether the law of the steadiness varying with the period is not fairly fulfilled, as a general law. I am not saying that there are not exceptions. You will find the "Lord Warden" has 62° of arc of oscillation, 5 to 5½ seconds period; the "Hercules" 8 seconds period, and less than half the angle.

Admiral FISHBOURNE: Would you kindly prove the connection? I have shown you another law, a law of weights, that they roll according to the weights. You should disprove the one, and prove the other; this you do not do.

Mr. WHITE: I must appeal to you, Sir. I am following, as far as I can, a particular line of thought with reference to Admiral Fishbourne's paper; and it is rather confusing to be interrupted. Respecting the exceptions, I should say these are cases which prove the rule. I may add, that the law of relation of period to steadiness is a direct deduction from a mathematical investigation; and if Admiral Fishbourne would like to follow it, I should be most happy to place it at his service. Now we will take another of his tables. Take Table V, which I consider one of the most composite constructions ever put on paper. Admiral Fishbourne has there taken two squadrons of ships—one English, the other French—which were at sea at different times, under circumstances which I am sure cannot be definitely compared, and which Sir Spencer Robinson, in reporting on the matter, says is a comparison to be taken simply for what it is worth. Any gentleman who wishes to test my accuracy upon that point can turn to the report of the Committee of Designs, 1871. In this table there is the "Achilles." The "Achilles" is a ship which Admiral Hamilton, whom I am glad to see is present, has himself told me, is a ship which in heavy weather behaves magnificently; she is also a ship of long period. Yet, on one occasion, in an almost glassy sea, the "Achilles" rolled more heavily than ever before. Why? She was of the same breadth, she had remained unchanged, but the state of the sea had changed, and Admiral Hamilton informs me again that, so

far as he could note, there was a very close approximation to synchronism between the roll of the ship and the swell that passed the ship. I have simply had the opportunity (which I am most proud to have had) of studying the results of observations made by gentlemen whose desire was not to prove one theory or disprove another, but who go to sea and give us the benefit of their experience; and I have come already to the opinion that the facts bear out very fully the relation between period and steadiness, and I think I have pointed out in these tables confirmatory facts. In Table IV, the "Lord Warden" is stated to have a meta-centric height of 4·6 feet, and Admiral Fishbourne says, one reason she behaved so badly was, that she had such a small meta-centric height. I do not know where Admiral Fishbourne obtained his figures for the meta-centric height, but, on carefully inquiring at the Admiralty, I am told the ship has never been inclined, so that the information given was scarcely trustworthy. The fact is, that the "Lord Warden" and "Lord "Clyde" have never been inclined; they are such broad "dumpy" ships that their stability is assured, and in all probability the "Lord Warden" has as great a meta-centric height as the "Caledonia." As the "Lord Warden" has never been officially inclined, it follows that the figures (4·6 feet) and the deductions based upon them are not correct. Turning to Table II, I believe I am right in saying, that those figures were taken from the capital accounts which appeared in the *Times* of the behaviour of the squadron in 1871. May I ask why Admiral Fishbourne did not say, "at sea, 28th September," and "at anchor, 19th September," because I think a day is quite ample time for some difference to arise in the seaway. There are two other most remarkable things in this table. I find from the *Times* that the ship which rolled most heavily when at anchor was the "Lord Warden" (36°), but the "Lord Warden" does not appear in that table. In the second half of the table, "for ships at sea," there is another most singular omission. There was one ship in that squadron which had a long period, but she does not appear at all. She was wonderfully steady, for while the "Caledonia" was rolling 50°, the "Monarch" only rolled 4°, but she is not named. There is another omission of the "Monarch" in Table IV, wherein the oscillation of the ships (the "Topaze" always being an exception, and a most remarkable one) has been shown to agree with the law, that the ships with long periods are steady, and the ships with comparatively short periods unsteady. The *Times* reporter, writing about the first half of the Table II said—and he had not any theory to support—the behaviour of the "Monarch" on that day at anchor was one of the most singular things he had ever seen. Her remarkable general steadiness was so utterly contradictory of her behaviour on that day. The natural inference is, I think, that there must have been something singular in the state of the sea. Next, I want to say a word respecting Admiral Fishbourne's deductions as to the relative steadiness of English and French ironclads. Those deductions are made by putting together trials made on different days at different states of sea. I do not think that anyone who has ever been at sea can expect that ships not tried simultaneously can assuredly be tried under identical conditions, and if not so tried, their qualities cannot be compared fairly. I do not look on this as at all a personal matter. I stand here as an unworthy advocate of a theory which I most firmly believe, a theory which the more I see of it, the more convinced I am that it is a wonderful advance upon anything which went before. The question of co-periodicity is a very old one; the ship falling in with waves having a period about equal to her still-water period is likely to be subjected to the heaviest rolling. That is no modern view, it is simply a deduction from a modern theory agreeing with a much older theory. Coming to Table III it scarcely appears to be a table you can put much trust in as a test of the behaviour of a ship. When a ship is rolling only 2°, the rolling requires very careful measurement; but I want to show that even taking these small rolls, the general law named at the outset holds. The periods are given in the table, but I must point out a mistake or two in the "period" column. 7½ to 8 seconds is about the period of the "Minotaur" class. It will be noticed that these three ships do not behave exactly the same: 5·2° and 8·6° are the respective arcs for the "Minotaur" and "Agincourt," which are sister ships. Now, look at the "Warrior." She has, we know, a shorter period than the "Minotaur" class, and rolled 10·5°. Next look at the "Inconstant;" she rolls only 2·5°; look also at

the "Hercules" and "Monarch," and it will be seen that the ships which rolled least are the ships with the longest periods. That is still further confirmation of the general law. But let me point out one apparent contradiction to that law. The "Volage" is credited in the table with a period of 10 seconds, and yet she was the heaviest roller. Now fortunately she has actually been rolled in still water, so that I can state with certainty that instead of her period being 10 seconds it is $5\frac{3}{4}$. This divergence shows that in such circumstances the rolls noted per minute do not always correspond with the true still-water period of the ship. On the whole, therefore, Table III may be claimed to be a still further confirmation of the view that ships with the longest period are steadiest in a seaway, other things being equal. I looked with great surprise at the tabular statement preceding Table IV, where Admiral Fishbourne had tabulated the figures from my tables in a particular way. Any one who will take the trouble to read my paper will find I did not put forward those figures as exact measures of the effect of period upon rolling. Sister ships are recorded as behaving very differently without any change of period, other points of differences influencing the behaviour. But in Admiral Fishbourne's statement you have put together as due to differences of period alone, differences of behaviour which I do not think should be classed under that head at all. They were due to other differences of condition of which the reports we get of the ship show nothing. Now I am going to base a still further argument for the modern theory upon Admiral Fishbourne's statement about the behaviour of the "Rodney" and "Albion," rather old ships now. On page 73 (9 of proof) Admiral Fishbourne says the "Albion" rolled 47° and had a period of $4\frac{1}{2}$ seconds, and the "Rodney" rolled 29°, and had a period of 7 seconds. Is not that exactly what the modern theory teaches? viz., that the longer period gives you the steadier ship? Of course I cannot now go through the whole paper; but I hope I have made good this position, that there is something to be said in support of the modern theory, and that a long period is conducive to steadiness. I want, however, again to give the utmost prominence to the statement that we have learned by experience. Now we know that bilge-keels can be trusted to make ships steadier. Such keels have been added in recent ships with an increase of stiffness and without any sensible loss of steadiness. Admiral Fishbourne criticises my statements as to the behaviour of the "Devastation;" but I look upon the experiments with the "Devastation" as the best possible proof of the important influence upon rolling of synchronism of the still-water period of the ship with the period of the wave. Admiral Fishbourne, no doubt inadvertently, made a great mistake and misrepresented what I said on this point. I said that in the trials of the "Devastation" synchronism with the waves was due to the fact that she ran away from the waves: but Admiral Fishbourne says: "The 'Devastation's' angle of roll was doubled by her steering a course "that *shortened* the wave period." I think it is possibly a misprint. I said that the course steered virtually "*lengthened* the relative wave period," and that fact makes all the difference. The ship's still-water period of course remained unaltered, but the effective wave period is affected by the speed of the ship and the direction in which she moves. And when the "Devastation" ran away from waves which had a shorter period than her own still-water period, and went obliquely, she followed just such a course as to make the waves just synchronous with her own still-water period.

Admiral FISHBOURNE: Do you say it was by accumulation?

Mr. WHITE: Yes. I say that with a long period there is much less chance of that synchronism being established which leads to accumulation: that is the view of the matter I put forward. I do not wish to trouble the meeting with any further remarks. I only wish to say that having carefully read Admiral Fishbourne's paper, I am of opinion that Admiral Fishbourne has not advanced any new fact which at all takes away from my belief in the practical accuracy—not the exact accuracy—attaching to the deductions from the modern theory of rolling as enunciated by Mr. Froude.

Mr. SCOTT RUSSELL: I need hardly repeat what I have once or twice said here, that I consider the opinions of a naval Officer upon the behaviour of ships, and upon the qualities every ship ought to have, as far more important than any ideas of a shipbuilder if he has not been to sea in his ships, and far more important than any notions of men who do not know what sea-going is. I therefore feel that we

are greatly indebted to an eminent member of the naval profession who has seen a great deal of service in the various oceans of the world, and who now takes the trouble to give us his ideas as to the qualities of a ship. Now, we have had a great deal of talk about modern science, and a great deal of talk about modern practice in recent times, and it has been very customary, and we have almost fallen into that groove this afternoon, that on the one side we should say science is everything, and on the other side we should say practice is everything. Now, in this case I really must come in as a reconciler of the two. I do think that a little science is a very dangerous thing, and I do think that a very great deal of science, if to it is added a very great deal of practical experience, make a compound of very great value. Now, with regard to the science in this point I agree with Mr. White, and I am quite sure Admiral Fishbourne will not say anything else, that the theory of the coincidence of waves and of periods of oscillation, and of periods of rolling and their effects upon one another, are something so long known and so well known to everybody that anything about the coincidence of oscillations and their effect on each other, and their stopping each other, and their increasing each other, has no novelty in it; and therefore if you were to say to me now "I assure you that in "the next voyage you make across the Atlantic I will ensure you waves of one "period for the whole length of your voyage there and back again;" I say if any man is theoretical enough to assure me of that, and was impractical enough to tell me to build a ship which should be in a certain non-synchronous relation to those particular waves, he would be certainly very theoretical; and I certainly should be very impractical if I dreamt of building a ship for any such theoretical sea. Now, then, I say that those sailors who are in the habit of going to sea in ships and of studying the relations of their ships to the waves of a storm and hurricane or a great swell, I say these men do rightly and well, and the more they study the waves of the sea, and study how to manœuvre the ships in relation to these waves when they come, the more they do that, the better. But the idea of building a ship merely that in some particular state of the sea its motions should be synchronous or unsynchronous with those waves is perfectly preposterous, and I say therefore that the mere period of the spontaneous and free oscillation of a ship going to sea is a matter of comparatively trifling importance; and with the knowledge of a sailor how when he gets into a sea with that period so to manœuvre his ship that the synchronism shall be of no importance, which I need not tell any sailor who is here, we all know how to do—I mean all of us who have spent, as I have, much of our life at sea—we all know when the period of the water is such as to make our ship roll, how to put our ship in circumstances in which she will not roll. That being so, I call that a mere element of manœuvring, and I do not call it in the least degree an element of the construction of ships. Mr. White gives, in my opinion of it, an utterly erroneous theory when he says "make ships for some one period of oscillation" for probably that ship in a voyage will never meet with waves for that period of oscillation, she will not have perhaps half-a-dozen times in her life. Therefore, I say do not make a ship for any such purpose. But what does he say? He says, "We first "make a ship which, from some other elements, has a great tendency to roll," and then he says "I counteract that tendency by doing what? by sticking on bilge-"keels," as if a bilge-keel was not an odious excrescence, was not a waste of material in the wrong place, and was not an utterly unseamanlike, unseaworthy expedient of a bad shipbuilder who had bungled and made a bad job. I say then that if you want to unite sound principles and sound practice you will accumulate the experience of good sailors and of good shipbuilders, and I am happy to say that there have been many shipbuilders for a couple of centuries who have known how to build good ships, and how to give them good qualities; and these men are perfectly sound while many of our modern imaginings are perfectly unsound. What then is the practical point in the construction of a ship? I will give it in the fewest possible words. In the first place, every sailor tells me that he wants in a seaway to have a steady platform for his gun. He does not say that he wants his gun to swing up and down once in so many seconds, he does not say he wants this platform to oscillate in this way and the other way. He says "I want a ship to give me the steadiest "gun platform I can have whatever be the state of the sea, and whatever is the "period of the oscillations of the waves." Now, is that a practical thing or is it

not? If that is a practical thing, then there is the first law of building a ship-of-war. Now, I say distinctly that the ship of the steady platform is the contrary of what this modern science recommends. Your time will not allow me to tell you what that ship is. If you wish to go into it at some other day, I shall be happy to show you what it is. But there is a ship with a perfectly steady platform, and I am sure Mr. White has studied the period of ancient naval architecture. I suppose he knows how they built steady ships? I suppose he knows how the wonderfully steady gun platforms of the French vessels were produced previous to the great wars?

Mr. WHITE: Sailing ships?

Mr. SCOTT RUSSELL: I know no reason why a steamer should not have all the qualities of a good sailing ship. If you say you will have a steady stable platform, I say the old-fashioned principles of shipbuilding show us exactly how to do that, and if Mr. White thinks that there is any escape for the shipbuilder out of it, in saying that he has now to build steam vessels and armoured vessels, I say, on the contrary, the very fact that you have to build steam vessels gives you the disposition of a thousand tons of ballast to put where you want it. And what is the thousand tons of ballast? It is the boilers and the engines and the propelling apparatus. There are a thousand tons of weight, which I have recently seen in modern ships, of whose building I won't say, distributed in the most uneconomical, unseaworthy, worst manner possible. I have seen the engines and boilers of steam vessels in our modern science ships so disposed, by the arrangement of weights, as to give the vessel all the worst qualities a vessel can possibly have. Now, I say there is no excuse for that, because when you have a thousand tons of engines and boilers, you have only to set your brains to work and settle where these engines and boilers shall be in reference to their stores of coal, and in reference to the other things in the ship, and you will be able, out of these combinations, to make the best possible ship. I go now to the next point. The next point after the stable platform is what? The next point is, that whatever be the periods, no matter what of the waves, the structure of the ship shall be such that her motion on the waves shall be an easy gentle motion and not a violent one. That you call a seaworthy ship; and if you have done the first thing, given her a stable platform, and then have done the second thing, which is to make her an easy and gentle roller, which has nothing whatever to do with this particular period of roll, then you have combined the two things wanted, a sea-going ship and a good gun-carrying ship. Now, when I tell you of the advantages you have in a modern steam-ship of disposing, at your will, of all the loads necessary to that ship in a wise manner, I say then, you know nothing of your practical business, nothing of the true theory of shipbuilding, if you cannot make your vessel with a stable gun platform and an easy gentle rolling motion at sea. Those are the two conditions; and if you follow those two conditions, I undertake that any sailor that takes out your ship will say "thank you "for having given me a good ship."

Admiral FISHBOURNE: With respect to the tables, I have given such tables as I had. I have always had a difficulty in getting data. Table V is not of my putting together. The ships are placed in order by Sir Spencer Robinson. In addition, the Admiralty report says that the French ships were under worse circumstances, because they had a beam swell. What I understand is, that if they had not had that beam swell, they would not have rolled so much, and yet, notwithstanding that, they do not roll so much as the English ships. Mr. White asserts and re-asserts the value of small meta-centric height and long period. He says there is a law, but fails to show it. Take, for instance, the French ships. They roll in the order of their weight. He is bound to show that that is not the case. That the difference in the angle of roll does not arise from the difference in their weights, but, from what he asserts, their long period. The contrary is established. Take these two ships, the "Volage" and Mr. Johns' vessel; they are two vessels with the longest period and largest angles of roll, 53° and 58°. It is a matter of fact that the "Volage" has a small initial stability and a ten seconds period. It is a matter of fact that she rolled 35° in one direction and 18° in another. And that deficient stability is identified above with a long period. Mr. White says her period is only 5¼. My answer is this: I do not care a straw for the period in still water, it is no measure of the period at sea, and in no case do we find the still-water period to be the same as the period at sea.

Mr. WHITE: May I be allowed to explain one thing? The modern theory does not suppose that the actual period of oscillation in a sea-wave is the same as the still-water period.

Admiral FISHBOURNE: I am stating the actual fact. I set no value at all upon the still-water period. What we want is the actual practical result at sea; is that ships shall not roll much at sea; is ships that will carry sail and be safe. The proposition on the part of Mr. Froude is to give them no stability. He says, "If a vessel "were without stability, whether that stability were due to a broad plane of flota-"tion or deeply-stored ballast, the highest wave would fail to roll her. What is the argument? We will give her as little stability as possible, because the more stability we give her, the more she will roll. We say, as a consequence of giving little stability to a ship, that she goes over far, steers badly, and cannot carry sail. I have given you quotations to prove that. Here is the "Sultan," she carries 600 tons of ballast, and her masts are cut. The "Shannon," she also has her masts cut. Why? I believe what Mr. Reed said was quite true—that there is no reason why armoured ships should not sail, except that they are not given stability to stand up and make their sails effective. Mr. White will not dispute Mr. Johns' statement, as he is a naval architect and was in the Admiralty, and he states that he was reluctant to come to the conclusion that he did; that the vessel he spoke of rolled 45° in one direction and 13° in the other. It was not until after a long series of trials that he acknowledged the fact. He gives her period as ten seconds. How do you explain that? I say there is no way of explaining it except in my way, and it must be patent to everybody that if she has a ten-seconds period, and the wave is five seconds, she can only have taken one-half of her roll when the second wave would come up; and that is the history of her rolling on her side—just what Mr. Johns describes. With respect to the "Achilles," I think I have explained what took place by reference to the case of the "Volage." It is a thing that may be seen any day in the river. A solitary wave will roll across, and if a vessel has little stability, such as the "Achilles," it will roll her in proportion to its rapidity and its size. I have seen one small wave in an otherwise glassy sea come in and almost roll a vessel over, washing everything off her deck, so that the men had to lash themselves in the rigging, they having seen it coming. It is caused by the impact of a solitary wave of great velocity, and I have no hesitation in saying that if ships with little stability are caught in that way, they may be turned right over, and therefore any one incurs a very solemn responsibility who gives small stability. Mr. White thought I had not fairly dealt with him. I said Mr. White himself did not approve of the theory, because he told you a number of different elements came in to modify the result. I gave his own language, but mark what is his answer—that there is no fear lest little stability be given now that we have found the value of bilge-keels. But what are the bilge-keels for? If the smallest stability and long period produces the result required, why do you want bilge-keels? Is it not a broken-down theory that needs to be patched up by bilge-keels? I think it is a matter of common sense that these bilge-keels will have a very contrary effect to that expected. In still-water rolling the ship will come to rest sooner, but when on the waves, slipping down the wave-face, bilge-keels will increase the danger, will trip her up. If bilge-pieces had been stuck upon the "Captain," she would have been capsized all the sooner: she would not have waited for the second wave. She would have rolled over the first time; and that is what the effect of bilge-keels will be. Then what is the use of ships if they will not steer? What can be more dangerous? Such ships are not safe-keeping company, and we cannot be surprised when we hear of ships running into one another, they not being under control. Mr. White has not made one single point in answer to my paper. He has implied that with respect to that table I have omitted some ships. I say I have omitted none. I have no object to serve by any such omission. They are old tables, brown with age; and they are not produced except to show this meeting the utter unwisdom of trusting to any one table. I do not care who the observer is, there are idiosyncracies—a personal equation—with everybody, and that is invariably siding in one direction. I believe the reason this theory has obtained such favour is because there was a preconceived idea. People say, "Sir William Thomson and Mr. So-and-so say it must be true." Mathematics are very good as long as the case is stated truly. We are told if the

vessels have no stability they will not roll at sea. Can you believe it? And yet it is upon that basis that Mr. White sets to work with his mathematics. Sir William Thomson has just looked at the calculations, and assumed that the statement of the case to which the mathematics were applied, was true. With respect to the Scientific Committee, it accepted Mr. Froude's principle as true, and made a report accordingly, but in the *interim* between the first and second report, the "Invincible" nearly capsized, and then what follows? Why, a practical repudiation of the theory; they say if it is possible to give more stability without increasing the rolling motions, such a thing would be very desirable. I say, what is giving increased stability but a practical break-down of the whole theory? The recommendation as to the "Inflexible" is to increase her breadth 10 feet and double her stability. That is a repudiation of the whole principle, which has been as little stability as possible, because increased stability produces short periods, and that is dangerous. Why, here they are producing short periods. How? By breadth; and they are producing short periods by these bilge-keels; the very thing they profess to dislike as dangerous they are bringing about, showing plainly enough they do not believe in the theory they have set up.

Admiral NOLLOTH: It appears to me that, taking the most favourable view of the theory of little stability, disadvantage preponderates.

If waves could be made to order, and the ship were constructed with a rolling period of the most suitable kind to avoid rhythm, synchronism of lee-lurch and wave-impact would still, as at present, frequently take place; and with ships of long period and concomitant large arcs of roll, I think the remedy would be worse than the disease.

In the case of huge ironclads with great momentum of sides when once in motion, and heavy wall-sided seas with no friendly slope gradually passing to leeward, and mitigating before arresting and finally reversing the direction of roll, little stability might prove of fearful importance.

In my humble opinion, decided advantage should be clearly established before consent be given to great restriction of the stability element in either ironclad or ordinary sailing-vessels.

Mr. SCOTT RUSSELL: I entirely agree with Admiral Nolloth that the theory of slender stability with long periods of roll is false and dangerous.

The CHAIRMAN: It now remains for me to give our thanks to Admiral Fishbourne, and on behalf of the Institution I may safely say we are all very glad indeed to welcome facts.

NOTE.—In justice it should be stated I was not aware how great was the estimated stability of the "Inflexible" when I read this paper. I had supposed, from Mr. E. J. Reed's statements, that she could have little more than he was in the habit of giving, *i.e.*, 3 feet of meta-centric height after 350 tons of ballast had been added, or less than 4 feet in the "Devastation," with an empty bottom capable of containing near 1,000 tons of water, whereas, the "Inflexible's" meta-centric height is 8·5 feet higher than almost any vessel's, except American monitors and the Russian circular ship, which has 8·9 meta-centric height.

Then as to her capsizing when well-nigh destroyed, it is only what sailors have to expect, as in the case of "Java" "Gueriere," and others. This chance can be reduced only by reducing the deep double bottoms introduced by Mr. Reed to "check rolling," erroneously, for it has the opposite effect, this has in some measure been done in the "Inflexible," or remedied by making ships unsinkable, as I pointed out in my lecture on the loss of the "Captain" in 1872, page 30. This has in part been attempted in the "Inflexible," by cork and other devices, while there is nothing of the kind in Mr. Reed's designs. So with equal accuracy of five vessels of Mr. Reed's design with meta-centric heights of 2·2 or 2·4 or even 3 feet, without clothing, or only 4 or 5 inches thick, would fail, while the "Inflexible" would practically be still safe.

It must be a subject of congratulation that the theory that for "a vessel *to be* "*safe she must have very little initial stability*," has been abandoned; for besides the damage entailed on many ships of the Navy, it had found its way into the Merchant Service, and had occasioned the foundering of several vessels and the loss of some of their crews.—E. G. F.

Evening Meeting.

Monday, February 4, 1878.

LIEUTENANT-GENERAL SIR JOHN H. LEFROY, R.A., K.C.M.G., C.B., F.R.S., in the Chair.

ON COMPASS ADJUSTMENT IN IRON SHIPS, AND ON A NEW SOUNDING APPARATUS.

By SIR WM. THOMSON, LL.D., F.R.S., Pres. R.S.E., Professor of Natural Philosophy in the University of Glasgow, and Fellow of St. Peter's College, Cambridge.

I.—*New Form of Marine Azimuth and Steering Compass with Adjuncts for the complete application of the Astronomer Royal's principles of Correction for Iron Ships.*

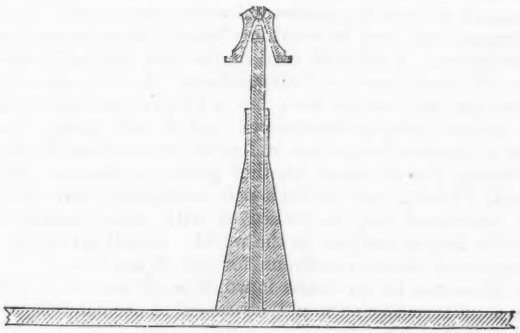
THIRTY-EIGHT years ago, the Astronomer Royal showed how the errors of the compass, depending on the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighbourhood of the binnacle. Partial applications of his method came immediately into use in merchant steamers; and, within the last ten years, have become universal not only in the merchant service, but in the navies of this and other countries. The compass and the binnacles before you are designed to thoroughly carry out in practical navigation, the Astronomer Royal's principles. The general drawback to the complete and accurate realisation of plans for carrying out these principles heretofore, has been the great size of the needles in the ordinary compass which renders one important part of the correction, the correction of the quadrantal error for all latitudes by masses of soft iron placed on the two sides of the binnacle, practically unattainable; and which limits, and sometimes partially vitiates the other chief part of the correction, or that which is performed by means of magnets placed in the neighbourhood of the compass. Five years ago my attention was forced to this subject through my having been called upon by the Royal Society to write a biographical sketch of the late Archibald Smith, with an account of his scientific work on the mariner's compass and ships' magnetism, and I therefore commenced to make trial compasses with much smaller needles than any previously in use; but it was only after three years of very varied

trials, in the laboratory and workshop, and at sea, that I succeeded in producing a mariner's compass with the qualities necessary for thoroughly satisfactory working in all weathers and all seas, and in every class of ship, and yet with small enough needles for the perfect application of the Astronomer Royal's method of correction for iron ships. One result at which I arrived, partly by lengthened trials at sea in my own yacht, and partly by dynamical theory analogous to that of Froude with reference to the rolling of ships, was that steadiness of the compass at sea was to be obtained not by heaviness of needles or of compass card, or of added weights, but by longness of vibrational period[1] of the compass, however this longness is obtained. Thus, if the addition of weight to the compass card improves it in respect to steadiness at sea, it is not because of the additional friction on the bearing point that this improvement is obtained; on the contrary, dulness of the bearing point, or too much weight upon it,

[1] The vibrational period, or the period (as it may be called for brevity) of a compass, is the time it takes to perform a complete vibration, to and fro, when deflected horizontally through any angle not exceeding 30° or 40°, and left to itself to vibrate freely.

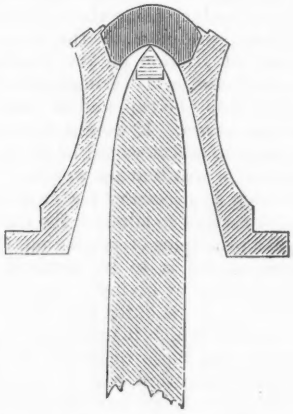
renders the compass less steady at sea, and, at the same time, less decided in showing changes of the ship's head, than it would be were the point perfectly fine and frictionless, supposing for the moment this to be possible. It is by increasing the vibrational period that the addition of weight gives steadiness to the compass; while, on the other hand, the increase of friction on the bearing point is both injurious in respect to steadiness, and detrimental in blunting it or breaking it down, and boring into the cap, and so producing sluggishness, after a short time of use, at sea. If weight were to be added to produce steadiness, the place to add it would be at the very circumference of the card. My conclusion was that no weight is in any case to be added, beyond that which is necessary for supporting the card; and that, with small enough needles to admit of the complete application of the Astronomer Royal's principles of correction, the length of period required for steadiness at sea is to be obtained, without sacrificing freedom from frictional error, by giving a large diameter to the compass card, and by throwing to its outer edge as nearly as possible the whole mass of rigid material which it must have to support it.

In the compass before you, these qualities are given by supporting the outer edge of the card on a thin rim of aluminium, and its inner parts on thirty-two silk threads or fine copper wires stretched from the rim to a small central boss of aluminium, thirty-two spokes, as it were, of the wheel. The card itself is of thin strong paper, and all the central parts of it are cut away, leaving only enough of it to show conveniently the points and degree divisions of the compass. The central boss consists of a thin disc of aluminium, with a hole in its centre, which rests on the projecting lip of a small aluminium inverted cup mounted with a sapphire cap, which rests on a fixed iridium point.



Eight small needles from $3\frac{1}{4}$ inches to 2 inches long, made of thin steel wire, and weighing in all 54 grains, are fixed like the steps of a rope ladder on two parallel silk threads, and slung from the alumi-

nium rim, by four fine copper wires through eyes in the four ends of the outer pair of needles.



The weight of the central boss, aluminium cup, and sapphire cap, amounts in all to about five grains. It need not be more for a 24-inch than for a 10-inch compass. For the 10-inch compass the whole weight on the iridium point, including rim, card, silk threads, central boss, and needles, is about 180 grains. The limit to the diameter of the card depends upon the quantity of soft iron that can be introduced without inconvenient cumbrousness on the two sides of the binnacle to correct the quadrantal error. If, as sometimes may be advisable in the case of a steering compass, or of a pole or masthead compass, it be determined to leave the quadrantal error uncorrected, the diameter of the compass card may be anything from 12 to 24 inches, according to circumstances. A 24-inch card on the new plan will undoubtedly have less frictional error or "sluggishness" for the same degree of steadiness than any smaller size; but a 12-inch card works well even in very unfavourable circumstances, and it will rarely, if ever, be necessary to choose a larger size unless for convenience to the steersman for seeing the divisions, whether points or degrees. Specimens of 12-inch, 15-inch, and 24-inch pole compasses have been made. The last mentioned may be looked at with some curiosity as being probably the largest compass in the world. It will no doubt be properly condemned as too cumbrous for use at sea even in the largest ship, but there can be no doubt it would work well in a position in which a smaller compass would be caused to oscillate very wildly by the motion of the ship.

The period of the new 10-inch compass is in this part of the world about 40 seconds, which is more than double the period of the A card of the Admiralty standard compass, and is considerably longer than that of the ordinary 10-inch compass, so much in use in merchant

steamers. The new compass ought, therefore, according to theory, to be considerably steadier in a heavy sea than either the Admiralty compass or the ordinary 10-inch compass, and actual experience at sea has thoroughly fulfilled this promise. It has also proved very satisfactory in respect to frictional error; so much so that variations of a steamer's course of less than half a degree are shown instantly and surely, even if the engine be stopped, and the water perfectly smooth.

With the small needles of the new compass, the complete practical application of the Astronomer Royal's principles of correction is easy and sure: that is to say, correctors can be applied so that the compass shall point correctly on all points, and these correctors can be easily and surely adjusted at sea, from time to time, so as to correct the smallest discoverable error growing up, whether through change of the ship's magnetism, or of the magnetism induced by the earth, according to the changing position of the ship. To correct the quadrantal error I use a pair of solid or hollow iron globes placed on proper supports, attached to the binnacle on two sides of the compass. This mode is preferable to the usual chain boxes, because a continuous globe or spherical shell of iron is more regular in its effect than a heap of chain, and because a considerably less bulk of the continuous iron suffices to correct the same error. When in a first adjustment in a new ship, or in a new position of a compass in an old ship, the quadrantal error has been found from observation, by the ordinary practical methods, it is to be corrected by placing a pair of globes in proper positions according to the following table:—

Table for Correction of Quadrantal Error.

Error to be Corrected.	Distances of the Nearest Points of Globes from Centre of Compass.										
	10-inch Globes.	9-inch Globes.	8½-inch Globes.	8-inch Globes.	7½-inch Globes.	7-inch Globes.	6½-inch Globes.	6-inch Globes.	5½-inch Globes.	5-inch Globes.	4½-inch Globes.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
°											
1	22·80	20·52	19·38	18·24	17·10	15·96	14·82	13·68	12·54	11·40	10·26
1½	19·30	17·36	16·39	15·42	14·46	13·50	12·54	11·57	10·61	9·65	8·68
2	17·06	15·36	14·51	13·66	12·81	11·95	11·10	10·24	9·39	8·53	7·68
2½	15·48	13·94	13·16	12·39	11·61	10·84	10·07	9·29	8·52	7·74	6·97
3	14·28	12·84	12·13	11·42	10·70	9·99	9·28	8·57	7·85	7·14	5·42
3½	13·32	11·98	11·32	10·65	9·99	9·32	8·65	7·99	7·32	6·66	5·99
4	12·52	11·26	10·63	10·01	9·39	8·76	8·13	7·51	6·88	6·26	5·63
4½	11·84	10·66	10·07	9·47	8·88	8·29	7·70	7·10	6·51	5·92	5·33
5	11·26	10·13	9·57	9·01	8·45	7·88	7·32	6·75	6·19	5·63	5·07
5½	10·76	9·67	9·13	8·59	8·06	7·52	6·99	6·45	5·91	5·38	4·84
6	10·40	9·27	8·75	8·24	7·72	7 21	6·70	6·18	5·66	5·15	4·53
6½	9·90	8·91	8·41	7·92	7·42	6·93	6·44	5·94	5·44	4·95	4·46
7	9·54	8·58	8·10	7·63	7·15	6·67	6·20	5·72	5·24	4·77	4·29
7½	9·20	8·28	7·82	7·36	6·90	6·44	5·98	5·52	5·06	4·60	4·14
8	8·90	8·01	7·57	7·12	6·68	6·23	5·79	5·34	4·90	4·45	4·01
8½	8·62	7·76	7·33	6·90	6·47	6·04	5·60	5·17	4·74	4·31	3·88
9	8·36	7·53	7·11	6·69	6·27	5·86	5·44	5·02	4·60	4·18	3·76
9½	8·12	7·32	6·91	6·50	6·09	5·69	5·28	4·87	4·47	4·06	3·66
10	7·90	7·11	6·72	6·32	5·93	5·53	5·14	4·74	4·35	3·95	3·55
10½	7·70	6·93	6·54	6·16	5·77	5·39	5·00	4·62	4·23	3·85	3·46
11	7·50	6·75	6·37	6·00	5·62	5·25	4·87	4·50	4·12	3·75	3·37
11½	7·32	6·58	6·22	5·85	5·49	5·12	4·76	4·39	4·02	3·66	3·29
12	7·14	6·43	6·07	5·71	5·36	5·00	4·64	4·29	3·93	3·57	3·22

When the quadrantal error has been thus once accurately corrected, the correction is perfect to whatever part of the world the ship may go, and requires no adjustment at any subsequent time, except in the case of some change in the ship's iron, or of iron cargo or ballast sufficiently near the compass to introduce a sensible change in the quadrantal error. The vast simplification of the deviations of the compass effected by a perfect correction of this part of the whole error has not, as yet, been practically appreciated, because, in point of fact, this correction had rarely, if ever, in practice, been successfully made for all latitudes. The pair of large needles of the compass ordinarily used in merchant ships does not, as has been shown by Captain Evans and Archibald Smith, admit of the correction of the quadrantal error in the usual manner, without the introduction of a still more pernicious error, depending on the nearness of the ends of the needles to the masses of chain, or of soft iron of whatever kind, applied on the two sides of the compass to produce the correction. The Admiralty standard compass, with its four needles proportioned and placed according to Archibald Smith's rule, is comparatively free from this fault: but even with it, and still more with the stronger magnets of the larger compasses of merchant ships, there is another serious cause of failure depending on the magnetism induced in the iron correctors by the compass needles, in consequence of which, if the quadrantal error is accurately corrected in one latitude, it will be found over-corrected in high magnetic latitudes, and under-corrected in the neighbourhood of the magnetic equator. The new compass was specially designed to avoid both these causes of failure in the correction of the quadrantal error; and experiment has shown that, with it the correction by such moderate masses of iron as those indicated in the preceding table, is practically perfect, not only in the place of adjustment, but in all latitudes.

When once the quadrantal error has been accurately corrected, the complete application of the Astronomer Royal's principles becomes easy and sure, if the binnacle is provided with proper appliances for readjusting the magnetic correctors from time to time, whether at sea or in port. But the system of nailing magnets to the deck, in almost universal use in the merchant service, is not satisfactory, and is often even dangerous. It always renders needlessly tedious and cumbrous the process of readjustment by the adjuster in port, and it leaves the captain of the ship practically no other method of readjustment at sea than removing the magnets altogether, or taking them out of their cases, and replacing them in inverted positions. The Astronomer Royal himself pointed out that his correcting magnets should be mounted in such a manner that their distances from the compass can be gradually changed, so as always to balance the ship's magnetic force as it alters, whether by gradual loss of her original magnetism through lapse of time, or by the inductive influence of the earth's vertical magnetic force coming to zero, and then becoming reversed in direction, when a ship makes a voyage from the northern to the southern hemisphere. The not carrying out of this essential part of his plan, whether through no method or no sufficiently convenient method of adjustment having

been hitherto provided, has undoubtedly taken away much of the credit among many practical men to which the Astronomer Royal's method is justly entitled. I have, therefore, introduced into the binnacles provided for my compass, when it is to be used in iron ships, a complete system of adjustable correctors for perfectly correcting the error of the compass for every position of the ship's head when she is on even keel, and a vertical adjustable magnet below the compass, for correcting the heeling error (more properly speaking a magnet, which is vertical when the ship is on even keel, and which shares the inclination of the ship when she heels over to either side).

An objection which has often been made to the use of correctors at all, and particularly to the use of correctors for a standard compass, is that they conceal the actual state of the ship's magnetism, and that readjustment of the correctors at sea leaves the navigator without means of judging, when he returns from a foreign voyage, how much of the changed error found on readjustment in port depends on changes which have been made in the correcting magnets, and how much on changes of the ship's own magnetism. This objection I meet by providing that at any moment my correctors can be removed or set to any degrees of power to which they may have been set at any time in the course of the voyage, and again reset to their last position with perfect accuracy. The appliances for changing the adjustment are under lock and key, so that they can never be altered, except by the captain or some properly authorised officer. Farther, to facilitate the use of the correctors, I graduate the scales accurately to correspond to definite variations of the force which they produce on the compass. Thus, as soon as the error has been determined by the known method of observation at sea, the corrector may at once be altered to the proper degree to correct it. Of course the officer performing the adjustment will satisfy himself of its correctness by a second observation. The objection of "delicacy of manipulation," and the difficulty of carrying it out, except by a professional adjuster, of which so much has been said, is entirely done away with when adjustable correctors, with scales thus accurately graduated, are provided with the binnacle.

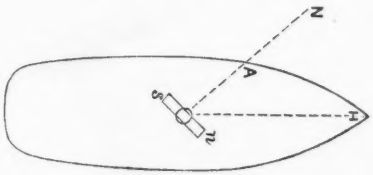
The binnacles before you are of two kinds, adapted to the two different methods given by the Astronomer Royal for correcting the semicircular part of the error; one, the square one, for correcting, by two sets of magnets, fore-and-aft and thwart-ship respectively; the other, the round one, for correcting by a single magnet, or group of bars equivalent to a single magnet, placed under the centre of the compass with its magnetic axis in the proper direction to balance the whole disturbing force on the compass due to that part of the ship's magnetism which is unchanged when she is put on different courses in the same magnetic latitude. The two sets of instructions, in the two printed pamphlets before you, explain sufficiently, for the two binnacles, the arrangements of the magnetic correctors in the two cases, and how to use them in practice.

The principle in each case is easily understood. In the system employed in the square binnacle the whole constant force, due to the part of the ship's magnetism which remains constant when the ship is put

on different courses, is regarded as being replaced by three constant "component" forces, in the direction of three lines, at right angles to one another—one fore-and-aft, one thwart-ship, and the third perpendicular to the deck. The fore-and-aft component is balanced by the fore-and-aft correcting magnets, the thwart-ship component by the thwart-ship magnets, and the component perpendicular to the deck by the heeling corrector, which is a bar-magnet, adjustable to the proper height, in a line perpendicular to the deck, through the centre of the compass and of the binnacle.

In the round binnacle the component perpendicular to the deck is balanced by a heeling corrector, just as in the square one; but, instead of considering separately two components parallel to the deck, their resultant or the single component parallel to the deck, which, with the component perpendicular to the deck, constitutes the whole force, is balanced by a single magnetic force parallel to the deck. This force is obtained by turning the revolving corrector round the central axis of the binnacle and raising it or lowering it until the proper direction and proper magnitude of force are produced.

One novel feature in the last binnacle is the way in which, by aid of the guide-ring graduated to logarithmic cosecants, and the vertical scale graduated to equal proportionate differences of force, the adjustment to correct the compass on one course may be performed without disturbing its accuracy on another course on which it has been previously adjusted. The principle of this arrangement is most easily explained by aid of the mathematical notation of trigonometry, in connection with the annexed diagram, in which O represents the compass



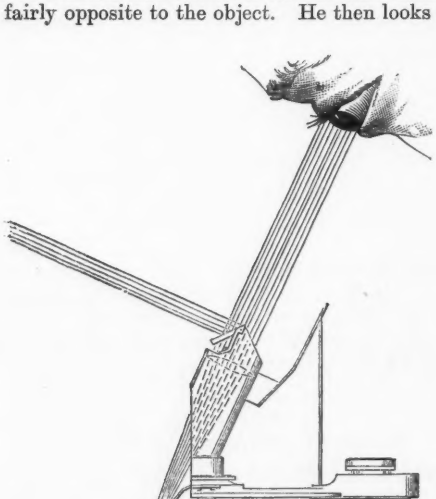
card, A, a point of the ship, which was in the direction of the correct magnetic north, N, at the time of the first supposed adjustment, *ns*, the position of the axis of the revolving corrector set to correct the compass on that course, H the ship's head. We have (according to the notation of the instructions)—

$$\text{HOA} = \text{H},$$
$$n\text{OH} = \text{C};$$
$$\text{therefore} \quad n\text{OA} = \text{H} + \text{C}.$$

Now the correction on the first supposed course, if it did not annul the force due to the magnetism of the ship and correctors, reduced it to a force in the line OA. Hence the component perpendicular to OA due to the corrector must be kept unchanged in subsequent correction, so as not to disturb the adjustment for that first course. Let F

be the magnitude of the force due to the revolving corrector. Its direction being On, its component perpendicular to OA is equal to F sin nOA. Hence, if F be increased by raising, or diminished by lowering, the corrector, the angle nOA must be altered so that sin nOA shall vary inversely as F, or cosec nOA directly as F. In other words, $\frac{\text{F}}{\text{cosec } n\text{OA}}$ must be kept constant, and, therefore, the difference between log F and log cosec nOA must be kept constant. When the guide-ring is placed according to Rule 2, section 4, of the Instructions, the reading upon it is the value of log cosec (H+C). The reading on the vertical scale is always the logarithm of F. Hence Rule 3 secures that the change of magnitude and direction of the correcting force does not vitiate the correction on the course H.

An important objection was made to me some years ago by Captain Evans against the use of quadrantal correctors in the Navy, that they would prevent the taking of bearings by the prismatic azimuth arrangement, which forms part of the Admiralty standard compass. The azimuth mirror applied to the compass before you was designed to obviate that objection. Its use even for taking bearings of objects on the horizon is not interfered with by the globes constituting the quadrantal correctors, even if their highest points rise as high as five inches above the glass of the compass-bowl. It is founded on the principle of the camera lucida. The observer when taking a bearing turns the instrument round its vertical axis until the mirror and lens are fairly opposite to the object. He then looks through the



lens at the degree divisions of the compass-card, and turns the mirror round its horizontal axis till he brings the image of the object to fall on the card. He then reads directly on the card the compass bearing of the object. Besides fulfilling the purpose for which it was originally designed, to allow bearings to be taken without impediment from the quadrantal correctors, the azimuth mirror has a great advantage in not requiring any adjustment of the instrument, such as that by which in the prism compass the hair is brought to exactly cover the object. The focal length of the lens in the azimuth mirror is about 12 per cent. longer than the radius of the circle of the compass-card, and thus, by an elementary optical principle, it follows that two objects a degree asunder on the horizon will, by their images seen in the azimuth mirror, cover a space of 1·12° of the divided circle of the compass-card seen through the lens. Hence, turning the azimuth instrument round its vertical axis through one degree will only alter the apparent bearing of an object on the horizon by ·12°. Thus it is not necessary to adjust it exactly to the direct position for the bearing of any particular object. If it be designedly put even as much as 4° awry on either side of the direct position, the error on the bearing would hardly amount to half a degree. If the instrument were to be used solely for taking bearings of objects on the horizon, the focal length of the lens should be made exactly equal to the radius of the circle, and thus even the small error of ·12° in the bearing for one degree of error in the setting would be avoided. But one of the most important uses of the azimuth instrument at sea is to correct the compass by bearings of sun or stars at altitudes of from 0° to 50° or 60° above the horizon. The actual focal length is chosen to suit an altitude of 27°, or thereabouts (this being the angle whose natural secant is 1·12). Thus if two objects whose altitudes are 27°, or thereabouts, and difference of azimuths 1°, are taken simultaneously in the azimuth mirror, their difference of bearings will be shown as one degree by the divided circle of the compass-card seen through the lens. Hence for taking the azimuth of star or sun at an altitude of 27°, or thereabouts, no setting of the azimuth mirror by turning round the vertical axis is necessary, except just to bring the object into the field of view, when its bearing will immediately be seen accurately shown on the divided circle of the compass-card. This is a very valuable quality for use in rough weather at sea, or when there are flying clouds which just allow a glimpse of the object, whether sun or star, to be caught, without allowing time to perform an adjustment, such as that of bringing the hair, or rather the estimated middle of the space traversed by the hair in the rolling of the ship, to coincide with the object. The same degree of error as on the horizon, but in the opposite direction, is produced by imperfect setting round the vertical axis in taking the bearing of an object at an elevation of 38°.

Thus for objects from the horizon up to 38° of altitude the error in the bearing is less than 12 per cent. of the error of the setting. For objects at a higher elevation than 38° the error rapidly increases; but even at 60° altitude the error on the bearing is a little less than half the error of the setting; and it is always easy, if desired, to make the

error of the setting less than a degree by turning the instrument so that the red point which you see below the lens, shall point within a degree of the position marked on the circle of the compass-card by the image of the object.

For taking star azimuths the azimuth mirror has the great advantage over the prism compass, with its then invisible hair, that the image of the object is thrown directly on the illuminated scale of the compass-card. The degree of illumination may be made less or more, according to faintness or brilliance of the object, by holding a binnacle lamp in the hand at a greater or less distance and letting its light shine on the portion of the compass-card circle seen through the lens. Indeed, with the azimuth mirror it is easier to take the bearing of a moderately bright star by night than of the sun by day; the star is seen as a fine point on the degree division, or between two, and it is easy to read off its position instantly by estimation to the tenth of a degree. The easiest as well as the most accurate of all, however, is the sun when bright enough and high enough above the horizon to give a good shadow on the compass-card. For this purpose is the stout silk thread which you see attached to the framework of the azimuth mirror in such a position that when the instrument is properly placed on the glass of the compass-bowl, the thread is perpendicular to the glass and through the central bearing point of the compass.

Another advantage of the azimuth mirror particularly important for taking bearings at sea when there is much motion, is that with it it is not necessary to look through a small aperture in an instrument moving with the compass-bowl, as in the ordinary prism compass, or in the original nautical azimuth compass (described 280 years ago by Gilbert, Physician in Ordinary to Queen Elizabeth, in his great Latin book, "On the Magnet and on the Earth a great Magnet"), which is very much the same as that still in use in many of the best merchant steamers. In using the azimuth mirror the eye may be placed at any distance, of from an inch or two to two or three feet, from the compass, according to convenience, and in any position, and may be moved about freely through a considerable range on either side of the line of direct vision through the lens, without at all disturbing the accuracy of the observation. This last condition is secured by the lens being fixed in such a position of the instrument that the divided circle of the compass-card is in its principal focus. Thus the virtual image of the divided circle is at an infinite distance, and the images of distant objects seen coincidently with it by reflection in the plane mirror show no shifting on it, that is to say, no parallax, when the eye is moved from the central line to either side. From the geometrical and optical principles explained previously, it follows also that if the azimuth instrument be used for taking the bearing of an object whose altitude exceeds 27°, then the effect of turning the frame carrying the lens and mirror in either direction will seem to carry the object in the same direction relatively to the degrees of the card; or in the contrary direction if the altitude is less than 27°. But if the altitude of the object be just 27°, then the azimuth instrument may be turned through many degrees on either side of the compass-card,

without sensibly altering the apparent positions of the objects on the degree-divisions.

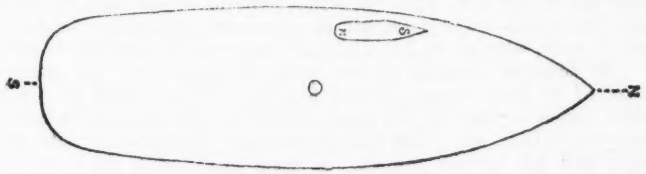
II.—*An Adjustable Deflector for completely determining the Compass Error when sights of heavenly Bodies or Compass marks on Shore are not available.*

About thirty years ago, Sir Edward Sabine gave a method, in which, by aid of deflecting magnets properly placed on projecting arms attached to the prism circle of the Admiralty standard compass, a partial determination of the error of the compass could be performed at any time, whether at sea or in harbour, without the aid of sights of heavenly bodies or compass marks on shore. The adjustable magnetic deflector before you is designed for carrying out in practice Sabine's method more rapidly and more accurately, and for extending it, by aid of Archibald Smith's theory, to the complete determination of the compass error, with the exception of the constant term "A" of the Admiralty notation, which in almost every practical case is zero, and can only have a sensible value in virtue of some very marked want of symmetry of the iron work in the neighbourhood of the compass.[1] When it exists it can easily be determined once for all and allowed for as if it were an index error of the compass-card, and it will, therefore, to avoid circumlocutions in the statements which follow, be either supposed to be zero or allowed for as index error.

The new method is founded on the following four principles:—

(1.) If the directive force on the compass needles be constant on all courses of the ship, the compass is correct on all courses.

[1] I had a curious case lately of effect of unsymmetrical iron on a midship steering compass, due to a steam-launch about 30 feet long placed fore-and-aft on the port side of the deck with its bow forward and its stern 5 or 6 feet before the thwart-ship line through the position of the compass. The compass having been adjusted by the globes and magnetic correctors to correct the quadrantal error (D), and the semi-circular error, it was found (as was expected) that the compass was correct on the east and west points, but showed equal westerly errors of about $3\frac{1}{2}°$ on the north and south points. There were, therefore, approximately equal negative values of "A" and "E" each $1\frac{3}{4}°$. The captain was, of course, warned of the change he will find when he is relieved of the steam-launch at Rangoon, the port of his destination. The explanation of the westerly deviation when the ship's head was north or south, by the inductive magnetism of the steam-launch, according to which its stern would be a true north pole when the ship is on the north course, and a true south pole when



the ship is on the south course, is obvious from the annexed diagram, in which the letters *n*, *s*, denote true north pole and true south pole of induced magnetism in the steam-launch when the ship's head is north magnetic.

(2.) If the directive force be equal on five different courses it will be equal on all courses.

(3.) Supposing the compass to be so nearly correct or to have been so far approximately adjusted, that there is not more than eight or ten degrees of error on any course, let the directive forces be measured on two opposite courses. If these forces are equal the compass is free from semicircular error on the two courses at right angles to those on which the forces were measured; if they are unequal there is a semicircular error on the courses at right angles to those on which the forces were measured, amounting to the same fraction of the radian (57·3°) that the difference of the measured forces is of their sum.

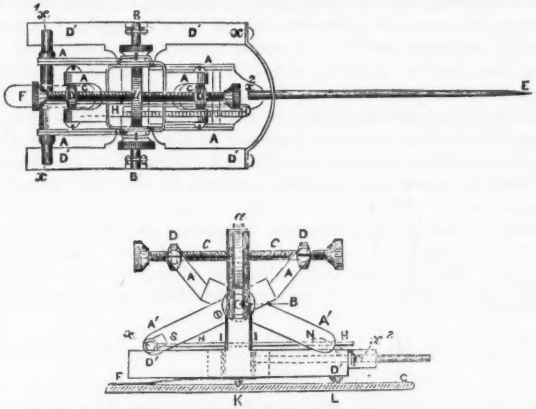
(4.) The difference of the sums of the directive forces on opposite courses in two lines at right angles to one another, divided by the sum of the four forces, is equal to the proportion which the quadrantal error, on the courses 45° from those on which the observations were made, bears to 57·3°.

The deflector may be used either under way or in swinging the ship at buoys. The whole process of correcting the compass by it is performed with the greatest ease and rapidity when under way with sea room enough to steer steadily on each course for a few minutes, and to turn rapidly from one course to another. For each operation the ship must be kept on one course for three or four minutes, if under way, by steering by aid of an auxiliary compass, otherwise by hawsers in the usual manner if swinging at buoys, or by means of steam-tugs. A variation of two or three degrees in the course during the operation will not make a third of a degree of error in the result as regards the final correction of the compass. The deflector reading is to be taken according to the detailed directions in sections 14 and 15 of the printed "Instructions." This reading may be taken direct on the small straight scale in the lower part of the instrument. The divided micrometer circle at the top is scarcely needed, as it is easy to estimate the direct reading on the straight scale to a tenth of a division, which is far more than accurate enough for all practical purposes. This reading with a proper constant added gives, in each case, the number measuring in arbitrary units the magnitude of the direct force on the compass for the particular course of the ship on which the observation is made.

The adjustment by aid of the deflector is quite as accurate as it can be by aid of compass marks or sights of sun or stars, though on a clear day at any time when the sun's altitude is less than 40°, or on any clear night, the adjuster will of course take advantage of sights of sun or stars, whether he helps himself also with the deflector or not.

The deflector consists of two pairs of small steel bar magnets attached to brass frames, jointed together and supported on a sole-plate, which is placed on the glass cover of the compass-bowl when the instrument is in use. The two frames carry pivoted screw nuts, with right and left handed screws. A brass shaft, with right and left handed screws cut on its two halves, works in these nuts, so that when it is turned in either direction one of the two pairs of north poles is brought nearer to, or farther from, one of the two pairs of south poles,

while the other two pairs of north and south poles are all in the line of the hinged joint between the two frames. This arrangement, which



DD, the gimballed nuts; CC, the right and lift handed screws; α, a divided micrometer circle to aid when very minute measurement of the distance between the poles is wanted; ABA′, ABA′, the two frames jointed round an axis through BB of the first diagram, and perpendicular to the plane of the second diagram through its central point B; NS, the effective true north poles and true south poles; HIIH, the scale indicating the distance between them; EG, the glass of the compass-bowl; K, the foot resting in the central conical hollow; L, one of the other feet; F, the spring to keep pressure on the feet LL. When the screw is turned so as to bring DD nearer one another the distance between S and N is diminished, and the axis BB rises with its ends B, B, guided by two vertical slots, of which both are seen in plane in the first figure, and one in elevation in the second figure.

constitutes, as it were, a jointed horse-shoe magnet, adjustable to greater or less magnetic moment by increasing or diminishing the distance between its poles through the action of the screw, is so supported on its sole-plate that, when this is properly placed on the glass of the compass-bowl, the effective poles move to and fro horizontally about half an inch above the glass on the two sides of a vertical plane through its centre. The sole-plate rests on three feet, one of which, under the centre of gravity of the deflector, rests in the conical hollow in the centre of the glass. It is caused to press with a small part of its whole weight on the other two feet by a brass spring attached to the bottom of the sole-plate on the other side of the centre from these two feet, and pressing downwards on the glass. A brass pointer attached to the sole-plate marks the magnetic axis of the deflector. It projects from the centre, on the side of which is the pair of true north poles. Thus, if the deflector be properly placed on the glass of the compass-bowl, with the pointer over the north point of the card, it produces no deflection, but augments the directive force on the needle.

To make an observation, the deflector is turned round in either

direction, and the north point of the card is seen to follow the pointer. The power of the deflector is adjusted by the screw, so that, when the pointer is over the east or west point of the card, the card rests balanced at some stated degree of deflection, which for the regular observation on board ship is chosen as 85°. A scale, measuring changes of distance between the effective poles of the deflector, is then read and recorded. For adjusting compass by aid of the deflector, the magnets are so placed that the deflector reading, found in the manner just described, shall be the same for the four cardinal courses; and also for one of the quadrantal courses if the compass is sufficiently affected by unsymmetrically placed iron to show any sensible amount of the "E" constituent of quadrantal error. When the deflector is to be used for determining the amount of an *uncorrected* error, according to principles (3) and (4) above, the magnetic value of its scale reading must be determined by experiment. This is very easily done on shore, by observations of its deflecting power when set by its screw to different degrees of its scale.

III.—*New form of Marine Dipping Needle for facilitating the Correction of the Heeling Error.*

This instrument is designed as a substitute for the vibrating vertical needle, hitherto in use for carrying out the observations of vertical force, whether on board ship or on shore, required for performing the operations described in Part III, section 4, and the last three pages of Part IV of the Admiralty Manual. It consists of a light bar magnet or "needle" of hardened steel wire, supported by means of a very small aluminium cradle on a stretched platinum wire, of which the two straight parts on the two sides of the needle are, as nearly as may be, in a line through its centre of gravity. One flat end of the needle is painted white, with a black line through its middle parallel to the platinum wire. When the instrument is properly placed for use the platinum wire is horizontal, and the needle is brought into a horizontal position by turning one end of the platinum wire until the elastic force of the torsion balances the turning motive (or "couple") due to the vertical component of the magnetic force of the locality. A divided circle is used (as the torsion head of the original Coulomb's Torsion Balance) to measure the degrees of torsion to which, according to Coulomb's original discovery, the turning motive is proportional. Thus, the magnetic moment of the needle being constant, the vertical component of the magnetic force in the locality of the observation is measured simply in degrees or divisions of the torsion head. A glass plate, fixed in a vertical position parallel to the platinum wire and close to the painted end of the needle, has a horizontal score across it on the level of the platinum wire. By aid of a totally reflecting prism, like that of the prismatic azimuth compass, with one side convex, the user of the instrument looking downwards sees when the black line on the end of the needle is exactly level with the score on the glass plate. This mode of sighting has proved very satisfactory; it is very easily and quickly used, and it is so sensitive that with the dimensions and magnetic power of the instrument before you it shows easily a varia-

tion of vertical force amounting to $\frac{1}{100}$ of the earth's vertical force in this locality. The accompanying printed instructions for the adjustment of my compass describe in sufficient detail the way of using it for correcting the heeling error.

In the instrument before you there is a divided paper circle in the bottom of the box to serve as a "dumb card," to be used with the azimuth mirror when there may be occasion for the use of a non-magnetic azimuth instrument. This appliance has nothing to do with the dipping needle, and is introduced, because while adding little or nothing to the cumbrousness of the instrument it saves the adjuster the necessity for carrying a separate azimuth instrument with him.

4. *Navigational Sounding Machine.*

The machine before you[1] is designed for the purpose of obtaining soundings from a ship running at full speed in water of any depth not exceeding 100 or 150 fathoms. The difficulties to be overcome are twofold; first, to get the lead or sinker to the bottom; and, secondly, to get sure evidence as to the depth to which it has gone down. For practical navigation a third difficulty must also be met, and that is to bring the sinker up again, for, although in deep-sea surveys in water of more than 3,000 fathoms depth it is advisable, even when pianoforte wire is used, to leave the thirty or forty pounds sinker at the bottom, and bring back only the wire with attached instruments; it would never do in practical navigation to throw away a sinker every time a cast is taken, and the loss of a sinker, whether with or without any portion of the line, ought to be a rare occurrence in many casts. The first and third of these difficulties seem insuperable, at all events, they have not hitherto been overcome, with hemp rope for the sounding line, except for very moderate depths, and for speeds much under the full speed of a modern fast steamer. It may indeed be said to be a practical impossibility to take a sounding in 20 fathoms from a ship running at 16 knots, with the best and best-managed ordinary deep-sea lead. Taking advantage of the great strength, and the small and smooth area for resistance to motion through the water, presented by pianoforte wire, I have succeeded in overcoming all these difficulties; and with such a sounding machine as that before you the White Star liner "Britannic" (Messrs. Ismay, Imrie, and Co., Liverpool), now takes soundings regularly, running at 16 knots over the Banks of Newfoundland and in the English and Irish Channels in depths sometimes as much as 130 fathoms. In this ship, perhaps the fastest ocean-going steamer in existence, the sounding machine was carefully tried for several voyages in the hands of Captain Thompson, who succeeded perfectly in using it to advantage; and under him it was finally introduced into the service of the White Star Line.

The steel wire which I use weighs nearly $1\frac{1}{2}$ lbs. per 100 fathoms, and bears when fresh, from 230 to 240 lbs. without breaking; its circumference is only ·03 of an inch. By carefully keeping it always, when out of use, under lime water in the galvanized iron tank pre-

[1] It weighs 22 lbs. For diagram see page 112.

pared for the purpose, which you see before you, it is preserved quite free from rust, and, accidents excepted, this sounding line might outlive the iron plates and frames of the ship. If the sinker gets jammed in a cleft of rock at the bottom, or against the side of a boulder, the wire is inevitably lost. Such an accident must obviously be very rare indeed, and there does not seem to be any other kind of accident which is altogether inevitable by care in the use of the instrument. The main care in respect to avoidance of breakage of the wire may be stated in three words—beware of kinks. A certain amount of what I may call internal molecular wear and tear will probably occur through the wire bending round the iron guard rod which you see in the after-part of the instrument, when, in hauling in, the wire does not lead fair aft in the plane of the wheel, as is often the case even with very careful steering of the ship; but, from all we know of the elastic properties of metals, it seems that thousands of casts might be taken with the same wire before it would be sensibly weakened by internal molecular friction. Practice has altogether confirmed these theoretical anticipations so far as one year of experience can go. My sounding machine has been in regular use in charge of Captains Munro and Hedderwick in the Anchor liners "Anchoria" and "Devonia" (Messrs. Henderson Brothers, Glasgow), for twelve months and seven months respectively, and in neither ship has a fathom of wire been lost hitherto, though soundings have been taken at all hours of day and night at full speed in depths sometimes as great as 120 fathoms. No break, not explicable by a kink in the wire, has hitherto taken place in any ship provided with the sounding machine. That it will bear much rough usage is well illustrated by one incident which happened in a cast taken from the "Devonia," running at 13 knots. The sinker in falling from the wheel into the water accidentally fell between the rudder chain and the ship, and 50 fathoms or so had gone out before it was noticed that the wire was running down vertically from the wheel instead of nearly horizontally as it ought to have been by that time. The handles were immediately applied to the sounding wheel, and it was turned round to haul in without reducing the speed of the ship. Though the wire was bent nearly at right angles round the chain until it was nearly all in, it was all got safely on board, as was also the cod-line with attached depth gauge, and the sinker at the end of it.

When soundings are being taken every hour or more frequently (as in the case of a ship feeling her way up Channel from the 100 fathom line when the position is not known with sufficient certainty by sights and chronometers) the sounding wheel should be kept on its bearings in position; with the cod-line, depth gauge, and sinker all bent on and ready for use. But in all other cases the wheel should be kept in its tank under lime water, and the cod-line with sinker and depth gauge attached should be kept at hand in a convenient place near the stand of the machine, which should be always fixed in position ready for use. With such arrangements, and methodical practice, as part of regular naval drill in the use of the sounding machine, one minute of time should suffice to take the sounding wheel out of its tank, place it on

its bearings, adjust the brake cord, bend on the cod-line, and be quite ready for a cast. When the machine is to be shown to an inspecting officer the wheel ought to be in its tank of lime water when he asks to see a cast. It should be carefully noticed that the ring at the end of the wire is securely lashed by small cord to the hole provided for it in the ring of the wheel whenever the cod-line is unbent from the ring. If the wire and ring are allowed at any time to knock about slack on the wheel when the wheel is being moved to be set up for use or to be replaced under the lime water there is a liability to some part of the wire getting a turn which may be pulled into a kink. One accident, at least, has happened in this way: the sinker dropped off carrying the cod-line and ring with it just as it was being let down from the taffrail for a cast. If the sinker had weighed 400 lbs.[1] it could not have broken the double wire next the ring without a kink.[1]

A description of the machine and rules for its use are given in the accompanying printed paper of instructions, to which I have only now to add a few words regarding the depth gauge. Erichsen's self-registering sounding lead (patented in 1836) depending on the compression of air might be used with my machine, but the simpler form before you is preferable as being surer. It too depends on the compression of air, but in it the extent to which the air has been compressed is marked directly on the interior of a straight glass tube by the chemical action of sea water on a preparation of chromate of silver with which the tube is lined internally. Between the salt of the sea water and the chromate of silver a double decomposition takes place. The chlorine leaves the sodium of the common salt and combines with the silver, while the chromic acid and oxygen leave the silver and combine with the sodium. Thus chloride of silver, white and insoluble, remains on the glass in place of the orange-coloured chromate of silver lining as far up as the water has been forced into the tube, and the chromate of sodium dissolved in the water is expelled as the air expands when the tube is brought to the surface.

My navigational sounding machine was brought into practical use for the first time in the steam-ship "Palm," belonging to Messrs. Charles Horsfall & Co., Liverpool, in a voyage to Odessa and back about a year ago, in command of Captain E. Leighton. I cannot illustrate the use of the machine better than by reading to you an extract from a letter I received last April from Captain Leighton, describing his experience of it in this first trial:—

"During the voyage in the 'Palm' steam-ship, which has just come "to an end, I took frequent opportunities of testing the sounding "machine when I had a chance of cross-bearings to verify the depths "as shown by chart, and always found it most accurate. For in- "stance, going up through the Archipelago and just after clearing the "Zea Channel, I got a good position by bearings, chart showing 79 "and 76 fathoms, two casts of your glass gave 78 and 75 fathoms. In "the Bosphorus also it gave capital results in 30 to 40 fathoms "water.

"The first real use I made of the machine was in the Black Sea

[1] See Appendix.

" during a fog which obscured everything. Wishing to make sure of " my position I put the ship's head for the land, and kept the machine " at work. After running in to 30 fathoms at full speed I slowed " down and went in to 12 fathoms, then hauled out to a convenient " depth and put her on the course up the coast. When it became " clear I found myself in a proper position, and no time had been lost " by stopping to sound.

" How many shipmasters let hours go by without obtaining sound- " ings, either because of the delay or on account of the danger of " rounding-to in heavy weather to get them, when, if they were pro- " vided with your sounding machine, they could have their minds set " at ease by having timely warning of danger, or by knowing that " they were in a good position ! "

I had myself very satisfactory experience of the usefulness of the sounding machine in coming up Channel, running before a gale of south-west wind in thick weather, on the 6th and 7th of last August, on returning from Madeira in my yacht—a small sailing schooner of 126 tons. About 5 A.M. on the 6th, I took two casts, and found 98 fathoms (sand and red spots) and 101 fathoms (sand and small shells). The mean with a correction of $2\frac{1}{2}$ fathoms to reduce to low water, according to the state of the tide at Ushant at the time, was 97 fathoms. Thenceforward I took a sounding every hour till eight in the evening. By writing these soundings on the edge of a piece of paper at distances equal according to the scale of the chart to the distances run in the intervals, with the edge of the paper always parallel to the course, according to the method of Sir James Anderson and Captain Moriarty, I had fixed accurately the line along which the vessel had sailed, and the point of it which had been reached, with only a verification by a noon latitude. At 6 o'clock next morning, by the soundings and course, with proper allowance for the flood-tide, I must have been about thirteen miles magnetic south of the Start, but nothing of the land was to be seen through the haze and rain; and with the assistance of about ten more casts of the lead (by which I was saved from passing south of St. Catherine's) I made the Needles Lighthouse right ahead, at a distance of about three miles, at 2 P.M., having had just a glimpse of the high cliffs east of Portland, but no other sight of land since leaving Madeira and Porto Santo. In the course of the 280 miles from the point where I struck the 100 fathom line, to the Needles, I took about thirty casts in depths of from 100 fathoms to 19 fathoms without once rounding-to or reducing speed; during some of the casts the speed was ten knots, and the average rate of the last 220 miles was a little over nine knots.

It is a pleasure to me to be able to add, that the sounding machine has also been successfully used in the Royal Navy. Admiral Beauchamp Seymour and Captain Lord Walter Kerr having kindly taken it on board H.M.S. "Minotaur" for trial last summer, Lord Walter Kerr wrote, on his return from Vigo, regarding it, as follows:—

" The sounding machine is most serviceable. We have been using it " constantly when running up Channel, from the time of crossing the line " of soundings to the time of reaching Plymouth; and, though running

"before a gale of wind, with a heavy sea, at the rate of ten knots, we "were able to get soundings as if the ship had been at anchor. We "were able to signal to the squadron each sounding as it was obtained; "thus, in thick weather, verifying our position by soundings without "having to round the ships to."

Appendix.

INSTRUCTIONS FOR THE USE OF SIR WILLIAM THOMSON'S NAVIGATIONAL SOUNDING MACHINE.

1. To prepare for sounding, the machine must be set up and securely fixed in its proper position over the stern of the vessel, the brake cord properly adjusted, the nine feet of log line bent on to the ring at the end of the wire, and the brass tube and sinker attached to the log line, according to the detailed instructions below. (Sec. 7, 8, 9).

2. *To take a Sounding.*—First, arm the sinker carefully, attending to the directions of Sec. 11 below. Then let it hang down direct from the wire wheel with one turn of the log line on the wheel. Put a glass gauge tube, open end down, into the brass guard tube, and put on the cap.

3. When ready for the cast lift the brake weight to its middle position: this releases the wheel which runs rapidly round till the sinker strikes the bottom. When the sinker touches the bottom, the wire immediately slackens and the wheel begins to stop. Watch the wire where it leaves the drum as it runs out, and when you see it slacken, immediately apply the brake to stop the wheel. Read the counter, bolt the handles, and instantly begin winding up the wire. When sounding at night, keep the light of a lamp on the wire where it leaves the drum, and watch it running out till it commences to slacken.

4. Wind in as quickly as you can, watching the sinker as it comes out of the water and the ring as it comes round the wheel. One turn of the log line round the wheel brings the brass tube to position: then stop winding; pull out the glass gauge tube, apply it (keeping closed end up) to the scale, and read off the number of fathoms shown on it by the lowest part of the red mark. This, without correction, will be the depth, accurately enough, if the barometer be at anything from $28\frac{3}{4}$ to $29\frac{1}{4}$ inches.

If the barometer stand at $29\frac{3}{4}$ add one fathom in 40.

"	"	30	"	"	30.
"	"	$30\frac{1}{4}$	"	"	20.
"	"	31	"	"	15.

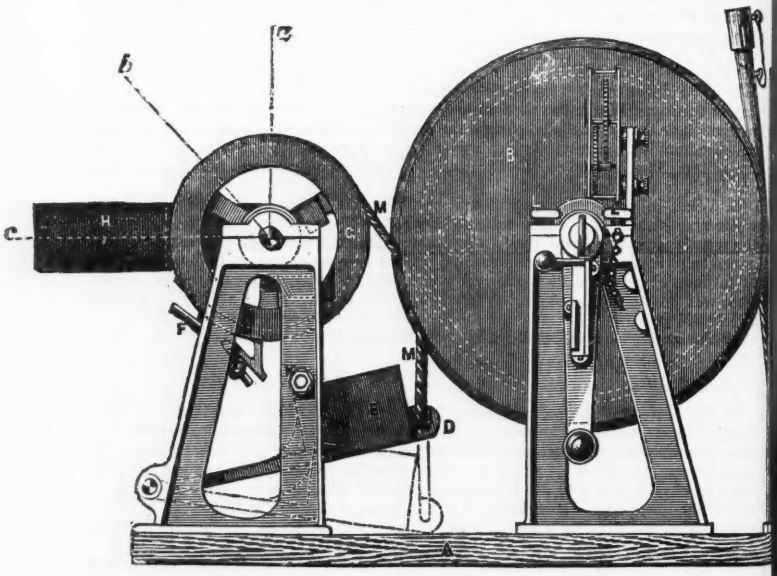
5. *Caution.*—In taking a cast be careful *not to lift the brake weight so high as to let the treadle rest on its lower stop.* To apply the proper resistance to the wheel to keep the wire taut when running out, *the treadle must hang free between its upper and lower stops.* If it is against the upper stop the resistance is too great and does not allow the wire to run out fast enough. If the treadle is let down so far as to touch its lower stop the resistance is too small, and there is danger of the wire shooting on and kinking when the sinker strikes the bottom. If the wire kinks in running out it is liable to be broken and certain to be damaged in being wound in.

6. *Regular Use of the Machine.*—When navigating out of sight of land in less than 100 fathoms, if there is any doubt as to the ship's position, whether from the sky not being clear enough for sights or from the errors of the chronometers not being known with sufficient certainty, the sounding machine should be kept going. Two men suffice to work it whatever be the speed of the ship. It takes from a few seconds to a minute for the sinker to reach the bottom from the time it is let go, and from a quarter of a minute to four minutes for two men to haul it in, if the depth is from 10 fathoms to 100 fathoms. (One man can haul it in though the ship be running at 16 knots, but not quite so quickly nor so uniformly as two.) Thus, it is easy to take a sounding every ten minutes, with an extra hand or two to relieve. One man should guide the wire, to make it lie evenly on the drum, with a piece of canvas covered with powdered quick lime. Two men can with ease take a

sounding every quarter of an hour, and this should be the rule whenever in keeping the machine thus going useful information as to the ship's place can be had. It is not necessary to use a tube every time. The reading shown on the counter at the moment the sinker strikes the bottom allows you to judge the depth surely and accurately enough if you use a tube occasionally. The reading on the counter shows approximately the number of fathoms of wire run out.[1] This may be something nearly twice the depth; but the proportion of wire to depth differs according to the depth, the speed of the ship, and the roughness of the sea. For the first of a set of casts use a tube and read off the depth accurately by applying it to the scale of fathoms. After three or four more casts use another tube, and then, according to judgment, use a tube as frequently as is necessary to check your inferences of depths from the counter readings. The character of the bottom brought up on the arming of the sinker is of course to be examined every time.

Detailed Instructions for Setting up and Adjusting the Sounding Machine.

7. The iron stand A of the machine is bolted or lashed to the taffrail, at the stern the vessel, or to a plank or platform properly fixed to support it, so that the



sinker when ready for a cast may hang over the water direct from the wheel, clear of everything,—the wheel B, on which the wire is coiled, being placed on its supports.

[1] Two turns of the wheel give about a fathom of wire; but this differs a little according to the quantity of wire on the wheel, and therefore if for any purpose, as for instance taking an up-and-down cast, which may be done in 300 fathoms water or anything less, with the wire ordinarily supplied on the wheel, the counter reading must be corrected according to actual measurements of the circumference of the wire-wheel when the sinker is at the bottom, and when the wire is wound on again.

8. The brake is to be adjusted as follows:—The rope MM securely knotted at one end is passed through the hole D in the end of the treadle E, then straight up and round the groove on the wire wheel B, and thence round the brake wheel G to the cleat F, where it is to be belayed. Before belaying it raise the weight H to the highest position shown by the dotted line at *a*, then pull the brake rope so taut that the end of the treadle E may just rest on the stand, and belay it so on the cleat.[1] With the brake in this position there is little or no resistance applied to the drum. Now allow the weight H to fall to its lowest position as shown by the dotted line at *c*, and the maximum resistance will be applied to the drum: this will suffice to prevent the wire from running out when the sinker is hanging over the stern. Lift now the weight H from its lowest and hold it in its middle position, shown by the dotted line at *b*: the treadle thus brought to hang free pulls the brake cord with a force of about 7 lbs., and produces a resistance to the wire running out equal to about 5 lbs.

9. Put the handles on, and screw up the pins in the side of the handles. The pins working in the grooves in the spindles prevent the handles from falling off. While the wire is running out, the bolts in the handles are withdrawn to allow the drum to revolve without carrying the handles with it.

10. *The Sinker* is a galvanized iron weight about 3 ft. 3 in. long, weighing about 22 lbs., with a hollow in its lower end to receive the usual arming of tallow, &c. It is attached to one end of a length of 9 feet of log line of which the other end is bent on to the ring at the end of the wire; one of the brass tubes *c* is lashed to this rope, as shown in the drawing, with its top end 3 feet from the ring.

11. When a cast is to be taken the hollow in the sinker is armed with tallow in the usual manner. It is advisable also to coat the sinker all round its lower end for about half an inch up the side with the tallow, so that if the edge should strike the bottom a specimen may still be obtained.

12. One of the prepared glass gauge tubes with its open end down is placed inside the brass tube, and the cap is put on the brass tube.

13. When, in taking a cast (Sec. 3 above) the weight H on the brake wheel is held by the hand in the position *b* shown on the drawing intermediate between the upper and lower positions, the end of the treadle E hangs from the cord M between the upper stop K and the base A, and, as stated above, pulls on the cord with a force of about 7 lbs., by which a resistance of about 5 lbs. is opposed to the wire while it is running out. This constant retarding force of about 5 lbs. stops the drum when, on the sinker striking the bottom, the wire ceases to pull with a force equal to it. When the wheel is seen to stop (Sec. 3), the weight H on the brake wheel is allowed to fall to the position *c*, whereby the full power of the brake is applied to the drum and prevents any more wire from running out. When the handles are applied to re-coil the wire on to the drum, the first effect of winding back the wheel is to lift the weight H on the brake wheel to its highest position. Thus the retarding force of the brake cord against the continued motion of the drum in hauling in is almost entirely removed. To entirely remove the brake resistance during a long haul, one of the men may hold up the weight H in its highest position.

14. When the machine is not required for immediate use unbend the log line from the ring. Lash the ring securely by small cord, passed through the hole in the rim of the wheel, to keep the wire firm on the wheel: take the wheel off its bearings and keep it in its galvanized iron tank covered with lime water to prevent the wire from rusting. The water may be kept constantly in the tank, and occasionally a lump of burnt lime dropped on the upper side of the wheel as it lies in the tank to keep the lime solution up to full strength.

15. One hundred prepared gauge tubes are supplied in a metal case with double sides. The space between the two sides can be filled with sea water, to allow of the tubes being kept at nearly the same temperature as the sea. If the temperature of the air in the gauge tubes is different from the temperature of the sea the results will be slightly vitiated. In preparing to take soundings in hot or sunny weather, the outer case should be filled with sea water which should be changed occasionally to bring the tubes nearly to the temperature of the sea before they are used.

[1] The brake cord must be occasionally tightened again on the cleat according to this rule, when it is found to have slackened by stretching in use.

List of Articles Supplied with the Sounding Machine.

The wire drum, with 300 fathoms of wire, and two handles.
Galvanized iron tank, in which the wire drum is to be kept covered with lime water when not in use.
Counter for showing the amount of wire out.
Four galvanized iron sinkers.
Four brass tubes.
Four galvanized iron rings.
One metal case, containing 100 prepared glass tubes.
Two fathom-rules.
Quick lime.

The CHAIRMAN: We have the pleasure of seeing in the audience several gentlemen of great experience in nautical observations. I trust some of them will favour us with remarks. Perhaps the Hydrographer of the Navy will favour us with his views.

Captain EVANS, R.N., C.B., Hydrographer to the Admiralty: I did not wish to speak, but being named by the Chairman, a few words may, perhaps, interest the meeting. There is no doubt that any instrument, especially a compass, brought forward by Sir William Thomson, will be thoroughly perfect in all its theoretical details. I have followed Sir William Thomson in the progress of this instrument to its present state; I know how he commenced the investigations relating to its construction, and it may be considered certain that every point he has brought forward to-night is theoretically correct. He has placed before you a compass, which, if the intelligence throughout the nautical profession came up to Sir William Thomson's standard, then, possibly, it could be used with perfect confidence. But that is the point; have seamen, as a rule, the intelligence to handle those delicate magnets which he applies? I am glad of one thing that he has done in this compass. He has brought forward, in a marked way, the advantages of small needles. That is a matter, the necessity of abolishing the use of long needles, which I have been long endeavouring to instil into seamen's minds. The idea of large compasses came in with large ships, but it was a great mistake: Sir William Thomson has worked to secure theoretically the most perfect compass, knowing that long needles were radically wrong in practice. It results that the compass we see before us requires management, differing entirely in system—not from that of the merchant service, for there there is no system—but from that organized in the Royal Navy. It is somewhat curious, that notwithstanding the several points of this instrument which I have stated as being theoretically accurate, its details should differ from those adopted in practice in the Navy. Those who have gone into the question, and know by experience what a dangerous instrument a magnet is to put in the hands of an unskilled seaman, hold it as a cardinal maxim the non-employment of movable magnets. In the Navy the custom is to determine experimentally the magnetic character of the ship, and that, I would observe, is a very important point:—every iron ship has a constitution of its own, much as a human being; and before a compass can be effectively applied in the iron ship (for the deviations of course are different in every part of her) you must know the magnetic constitution of the individual ship. Well, it may be considered strange, but there are, perhaps, not twenty men in Europe who have gone thoroughly into that special branch of the subject, the magnetic constitution of the ship. When that constitution is known, we see not only the advantages, but the security of permanently fixed magnets; you further then insist upon the principle that the seaman is not to consider that his compass is perfect in its pointing; he must always consider it imperfect. Sir William Thomson strives—which is a fine idea—to have a perfect compass. If the seaman has the technical knowledge to make it, by the use of the appliances, a perfect compass, well and good, but until he has that knowledge, I venture to think it should have trial in the hands of ordinary seamen, say in the merchant service, before it can be pronounced to have, although theoretically a beautiful and perfect

compass, all the practical advantages demanded for service afloat. Sir William Thomson dwelt for some time upon the quadrantal deviation; in aiming to do away with, or rather to neutralize this deviation, he has brought about all these beautiful devices. The quadrantal deviation, however, is not a very formidable error under ordinary circumstances, either in merchant ships or at the standard compass position in ships of war. This deviation further does not change on the ship proceeding to any part of the world, and it thus becomes a check upon compass observations made by the navigator. If a deviation table has not been constructed with proper care, we can apply this test of the quadrantal amount, to see where the errors exist. Supposing the compass before us was introduced generally, there will be this difference between the two systems of management: in the one you must know the magnetic constitution of the ship, then adjust your magnets permanently, and observe the errors constantly. In Sir William Thomson's compass you need not know the ship's constitution, but must trust, day by day, to your technical knowledge and skill in utilizing these delicate adjustments. Therefore, it appears to me to come to this—theoretically, Sir William Thomson gives you something approaching to perfection; but practically, you are brought up by the performance of details, which demand far more intelligence and knowledge than we know to exist among seamen. A practically accurate and reliable system of compass management is a very complicated, and, to some extent, an abstruse question, and there is far more in it than lies upon the mere surface of a compass as you see it in ordinary action. An Officer will say, "Oh, that is a beautiful compass, as steady as possible; never had a "better." These opinions are not worth much unless we know all the conditions on which the judgment has been given. Some Officers consider the same compass should be good in a gale of wind, and should be equally steady under concussion when firing broadside guns, that almost shake the teeth out of men's heads: that it should be equally reliable when the ship is steaming along steadily, or when she is going at high rates of speed: they think, in short, the same individual compass should be efficient under all these varying conditions. It is an impossibility; you must have a difference of arrangement in the compass to meet these various conditions. Sir William Thomson has brought proof of the periods of oscillation being so much in favour of his very small and delicate needles. I believe all this to be perfectly sound in theory, but the question is, how will such delicate arrangements answer in practice for active and prolonged service afloat? These are the chief points which present themselves for consideration.

The CHAIRMAN: I think we have Mr. Siemens here—we shall be very glad if he will offer any observations upon the subject of Sir William Thomson's sounding apparatus. The inventor of the bathometer, one of the most remarkable applications of science in our day, cannot fail to take an interest in other means of sounding to great depths.

DR. SIEMENS, F.R.S.: I did not intend to trouble you and the meeting with any observations of mine. The beautiful instrument Sir William Thomson has brought before us is entirely different in its principle from the attempt I have made to ascertain the depth, without material contact between the bottom of the sea and the ship. That problem is one which I am following up with considerable interest in my leisure hours, but the instrument which Sir William Thomson has brought before us is one that has already received the sanction of practice. It is one which is, I believe, of great value to the navigator, because it gives him the means of ascertaining the depth below the ship in shallow seas, without stopping the ship. With the ordinary sounding line, as we all know, if the depth exceeds five or six fathoms, the ship has to stop to take soundings. Sir William Thomson, with his beautifully adjusted wheel and his sounding wire, is able to reach the bottom without stopping the ship in its motion, and he receives a record of the hydrostatic pressure at the bottom of the sea in a tube, sealed at one end and covered with a chemical preparation on its inner surface, which is turned white, as we have seen, to the point to which the sea water penetrates in compressing the air before it. He thus brings to light the record of the pressure, and with it the record of the depth below the ship, and, as he has explained, is able to approach land in the time of dense fog, feeling his way, as it were, on the bottom by this beautiful machine. My own instrument, the bathometer to which you alluded, will be applicable chiefly for the guidance of the navigator as to his position when he has passed from the

ordinary soundings to deep-sea soundings, which could not be accomplished even with Sir William Thomson's wire without stopping the ship and without considerable loss of time. I hope that both Sir William Thomson's and my own instruments will ultimately prove of real service to the navigator.

Admiral RYDER: Would Sir William Thomson tell us how many of the tubes he proposes each ship shall be supplied with before she goes out on a three years' commission?

Sir WILLIAM THOMSON: About 500 tubes.

The CHAIRMAN: I have been very much interested in the remarks that dropped both from the Hydrographer and Sir William Thomson with regard to eliminating from compasses that which is a part of them as they are matter, but not a part of them as they are magnetized matter, namely, their inertia. Many years ago it fell to my lot to make observations on the motions of magnetic bars varying from two feet to three inches in length, and it was curious to find that when there were no circumstances affecting them to throw them into agitation their positions agreed; but the moment the heavy bar got a swing upon it, it became wild, the oscillations overran one another, and there was little correspondence between their motions and those of the lighter magnets. That is true of every compass, whether it weighs as many grains as Sir William Thomson's compass or as many ounces as they formerly did. On that point I was very much struck by what has been said. The only part which I confess I feel unable to follow him in, is with regard to the magnetic inclination which is to be determined by some balance of torsion. However, it is difficult, I believe, to see such a subject clearly without an instrument in our hands. Perhaps Sir William when he comes to reply will throw a little more light upon that part of his subject.

Staff-Commander HULL, R.N.: There has been a difficulty, I believe with Sir William Thomson's compass, in some experiments made in the "Minotaur" during the firing of her large guns, and from a report which has reached me I believe his compass has not done so well as the Admiralty compasses under the same circumstances. Perhaps Sir William Thomson, who I think also knows something of this, would give us some idea how he proposes to place his compass on a level with the Admiralty compasses, the action of these large guns being considered.

Captain LONG, R.N.: I think, Sir, as no one appears to have had any experience of Sir William Thomson's compass, I should like to inform the meeting I had the pleasure of going across the Atlantic the other day steered by one of these compasses, which was placed just abaft the iron mast, and the Captain told me it was the only compass he had ever had which could be used in that position. It so happened the position of the wheelhouse was very close to an iron mast, and this compass was used all the way across with great success. It was on the White Star steamer "Germanic," and she averaged 14 knots the whole way.

The CHAIRMAN: I think Captain Maclear can tell us something of the application of Sir William Thomson's sounding machine; if I am not mistaken, the "Challenger" was provided with it. At all events, I am sure Captain Maclear can give a valuable opinion upon this, as he can upon any other subject embraced by the duties of a scientific Officer.

Captain MACLEAR: I have a few words to say about the sounding machine in the "Challenger." It was proposed at one time to use Sir William Thomson's sounding machine, and we were provided with the original wheel that he made, and with his wire. Sir William had been good enough to show it and to explain the working of it to me at the meeting of the British Association at Brighton in 1872 before we left. One great thing that determined that we should not use it on board was that we required in the "Challenger," not only to find out the depth, but also to send down water bottles, several thermometers, pressure gauges, and other instruments, making a very heavy weight and of great value. I mean not only their intrinsic value, but their value as instruments whose errors had been determined. There is one very great fault with wire used as sounding line, that is, if it takes a kink anywhere, catches under the keel, or gets a nip anywhere, it parts instantly; and Captain Nares after consideration determined that it was far too great a risk to run with the instruments to chance the loss of so many of them by a nip of the wire. If we were sounding simply for depth it would matter little, because we could carry

a great number of wires; but when we have a great number of instruments depending on this line it becomes a matter of great moment that we should recover them. We cannot carry an unlimited supply of valuable instruments. That was what determined the disuse, and the best hemp was used instead. I know the wire has many advantages over hemp in sounding, but there is this very serious disadvantage, that it will not stand a sudden jerk, and it will not stand a nip, and if you are working in very great depth where the sounding has to occupy some time, not minutes, but perhaps half an hour, or an hour, or more than that, and in different sorts of weather, it is hardly possible to avoid sometime or other getting the line under the keel or making a sharp angle somewhere, and then on the first motion of the ship the line and everything else is gone. That is the only disadvantage that I know of. It is of very great value for ordinary sounding; but in the case in point in the voyage of the "Challenger" that is what prevented its use. I would also mention the difficulty of attaching thermometers to the wire at different depths.

Sir WILLIAM THOMSON in reply said: Captain Evans stated that it was his rule to admit no movable magnetic correctors. I cannot admit the practicability of that rule. As a matter of fact it is not, and cannot be carried out in practice. The magnets used to correct the compass must be movable, and are movable by irregular, if not by regular, means in every ship. For many short voyages, and even for voyages from Glasgow or Liverpool to New York and back, it may be generally advisable not to alter the correcting magnets in the course of the voyage. But if a ship goes to the southern hemisphere, it is frequently found that error grows up to a very inconveniently great degree in a compass which was correct when leaving England, and it sometimes happens that the magnets are found to be increasing the error instead of diminishing it. In such cases, unless provided with some regular means of moving or changing the correcting magnets, the navigator has no resource but to tear one or more of them off the deck when the system of fore-and-aft and thwart-ship magnets nailed to the deck is adopted; or, with a screw-driver, to take off the brass cap from the hole in the teak column in which the single magnet of the Admiralty system is placed, and remove or invert the magnet. I thoroughly see the importance of taking every security against any tampering with the magnets, and therefore in my binnacle I put them under lock and key, which is surely a better security than a lead cover nailed to the deck over the magnets, or a brass plate on the side of the binnacle removable by a screw-driver. Suppose it is ordered that during a particular voyage, or for a certain time, the magnets shall not be altered—the binnacle is locked and the key is put into the hands of a responsible Officer. In merchant ships of the better class, and in the Royal Navy, the management of the compass is safe in the hands of the Captains and navigating Officers; with discretion, in accordance with definite general instructions, to change the correctors gradually according to observations made at sea or in harbour from time to time: but whether the magnets are to be changed by the Officers of the ship when change is needed, or only by professional adjusters coming on board occasionally, the system of keeping them under lock and key in the binnacle gives much more security against any accidental or unauthorised disturbance than the systems hitherto in use, whether in the Royal Navy or in merchant ships.

Captain Evans has done ample justice to the instruments and methods before you in saying that they are theoretically perfect; but if they are not also suitable for practical work they have no right to be here, nor to be admitted on board ship. The Admiralty Manual, by Captain Evans and Mr. Archibald Smith, is perfect in theory; it gives the theory of the effect of ship's magnetism upon the compass most admirably; I believe as well as it can be given. I have only endeavoured very humbly to put in practice some of the theoretical conclusions to be found in the Admiralty Manual.

I read[1] in it, with reference to the quadrantal error, "the correction made by the "soft iron correctors is not affected by any change of magnetic latitude of the ship, "and when once made should remain perfect at all times." Then I say it ought to be corrected both for the standard and the steering compass of every ship, and I do not think the Admiralty system, according to which "the quadrantal deviation is not

[1] Admiralty Manual, Part IV, Page 95. Edition 1874.

"often corrected mechanically, but is generally left for tabular corrections,"[1] can be defended as a good practical rule.

The correction of the quadrantal error by the Astronomer Royal's method vastly simplifies the compass problem for the navigator, and diminishes the risk of mistake. It will also very considerably diminish the labour, in the Compass Department, of performing the analysis, according to Archibald Smith's method, by which the accuracy of the observations which have been made at sea is checked, and the magnetic history of the ship recorded.

Captain Evans remarked that it is expecting too much of a compass to expect that it shall be convenient for all uses; that the same compass shall be not only accurate as an instrument of navigation in smooth water and in a steady ship going at a moderate speed, but that it shall work well at full speed trials, in gun practice, and in a heavy sea. I quite feel that that is, perhaps, expecting too much; but if, as I hope may be the case, it turns out that these expectations can be realised, then it may be admitted that the attempt to realise them was not visionary or unpractical. The compass before you (besides being adapted, which was its primary object, to admit of the perfect correction of the quadrantal error) has been amply proved by experience to fulfil two of these other four conditions, to which Captain Evans has referred; it is not only accurate as an instrument of navigation in favourable circumstances, but it has been found to be very remarkably steady in the heaviest sea. It may oscillate through two or three degrees when the ship is rolling so much that one of the ten-inch compasses of the merchant service oscillates through ten or twelve degrees, and the Admiralty standard compass in the same circumstances as much as twenty degrees. [*Addition.* In such circumstances the Admiralty rule[2] is to substitute the heavy J card for the A card. The result cannot but be unsatisfactory, as must be every attempt to overcome unsteadiness by increased friction on the bearing point.] As to unsteadiness of the compass in a position in which there is great vibration on account of the screw propeller, or any other part of the machinery in the ship, the ultimate remedy in extreme cases it seems must be elastic suspension, but the peculiar mode of connection, by silk threads, between the rim and the central cap, and the needles, seems to give the compass before you considerable advantage in this respect over compasses of the ordinary form. Out of about 150 which have been sent to sea within the last 14 months, four only have been complained of as having shown unsteadiness on account of the tremors of the ship.

In one of these instances (the steamer "North Eastern," plying between Ardrossan and Belfast) the fault was completely corrected by substituting another bowl more heavily weighted with lead, and with a little more castor oil in the double bottom; and the compass has been found to have been remarkably steady, and to have worked in a perfectly satisfactory manner during six months since the change was made. It may be fairly expected that, if not by so simple a remedy as this, at all events by proper elastic suspension, the unsteadiness will be perfectly overcome in the other three cases. The behaviour of my compass under gun-fire hitherto has not been altogether satisfactory, although it was at first very promising; and I still trust it is not going to ultimately disappoint the most sanguine expectations. It was tried by kind permission of Captain Grant during a day's gun practice on board H.M.S. "Flirt" in the Frith of Clyde, in the autumn of 1876, and again on board H.M.S. "Gorgon" off Plymouth, by kind permission of Admiral Sir Thomas Symonds; and on both of those trials its behaviour was most thoroughly satisfactory. The card never moved more than four or five degrees on the occasion of any single discharge or of a broadside of the "Gorgon's" 18-ton guns, and often not perceptibly, or not more than a degree or two, when other compasses were set into violent oscillation, and sometimes sent flying quite round. From the German Admiralty I have an official report regarding one of my compasses, used as steering compass on board the ironclad "Deutschland," of the German Imperial Navy, to the effect that it was exceedingly steady whether in rough water or smooth, and notwithstanding violent agitation produced by a machine for lifting ashes from the

[1] Admiralty Manual. Part IV, Page 90.
[2] *Ibid.* Edition 1874. Page 184.

furnace under the bridge on which the compass was placed, and that the only exception to its steadiness was during gun practice, when it was sometimes set into considerable oscillation.

In answer to the Chairman I may explain that the determination of the "dip" or "magnetic inclination" though not the immediate object of the new form of dipping needle which I have brought before the Institution, can be performed at sea by combining observations taken by its aid, with proper observations for measuring the horizontal force.

In answer to Captain Hull's question, I may say that by an unofficial report from H.M.S. "Minotaur," I learn that during gun practice the cap of my compass was thrown off the bearing-point, so that for the time the compass was disabled. No damage however was done, and a temporary guard to prevent a similar accident from occurring again, has been applied to the roof of the compass bowl. No such accident had ever happened before, but the liability of its possibly happening having been proved by the experience of the "Minotaur's," I have added a guard of a permanent character which will be applied to every compass bowl designed for use in ships of war in future (and probably also for merchant ships, as at all events it does not in any way impair the efficiency and convenience of the compass for ordinary use, and it may in some rare cases be useful). With this and with a proper elastic suspension I have every hope of being able to render my compass continuously available for the navigation of the ship in every contingency of gun practice.

Returning to the subject of compass correction. The correction of the quadrantal error, though admittedly possible with my compass, has been spoken of by Captain Evans as not very important. Now, considering that the quadrantal error is scarcely ever less than six degrees, and is often as much as nine or ten degrees in merchant steamers, and in the standard compasses of modern war ships, I think the practical value of a complete correction of this error is very clear. For the same amount of maximum error, the quadrantal error changes twice as rapidly as does the semicircular error, and therefore a quadrantal error of eight or ten degrees is much more embarrassing than a semicircular error of the same amount. A quadrantal error of ten degrees implies a change in the error of the compass amounting to as much as half a point with so small a change as a point and a half in the ship's course from one side to the other of any of the four cardinal courses.

I wish, in conclusion, to express the strong feeling of admiration I have for the thorough system of analysis conducted for many years by Captain Evans, and continued by his successor in the Compass Department, Captain Mayes, by which all the observations reported to the Department by the Navigating Officers of the Royal Navy are rendered available for obtaining and keeping on record a knowledge of the magnetic history of every ship, and to express my cordial appreciation of the Admiralty Manual, due to Captain Evans and Archibald Smith, which has been and is the guide not only for the British Navy but for the navies of the world, and for every sailor or landsman who has endeavoured to make himself acquainted with the theory and practice of compass correction in iron ships.

The CHAIRMAN: At this late hour nothing remains for me to do except to convey the thanks of the United Service Institution to Sir William Thomson for the very able lecture that he has given us. The Institution must feel honoured when scientific men of the highest rank come before us, who may in some sense claim to be experts in this matter. I do not, of course, refer to myself, but to a large number of Officers round me, experts in whatever relates to observations at sea, and whose experience embraces conditions which can scarcely be realized artificially. Sir William has brought this subject before us with a degree, if he will permit me to say so, of modesty, which I think is not less admirable than the clearness and lucidity with which he explained his views. I am sure you will all very heartily join in expressing our thanks to him for his extremely interesting lecture.

LECTURE.

Friday, 18th January, 1878.

MAJOR-GENERAL SIR GARNET WOLSELEY, K.C.B, G.C.M.G., &c., &c., in the Chair.

ON MILITARY EQUIPMENT.

By Lieutenant F. J. GRAVES, 20th Hussars.

THE question of Military Equipment has for some time past been occupying considerable attention, not only among military authorities, but among many classes of civilians. It is generally felt that as war is a progressive science, so the various implements and articles of equipment pertaining to it must necessarily be of such a character as will in the best possible manner fulfil the various needs of war as they arise. Change, then, becomes necessary; but changes may be made without sufficient ground, and simply for the sake of change. I can only hope, however, that such changes as may be proposed in this lecture will be found to have a good basis of fact, and the opinions of great men founded on fact to support them.

With regard to the dress, &c., of Officers, an opinion is gaining ground that we want more simple dress for actual work; that gold belts and silver pouches would be advantageously replaced by white belts and cases, with compass and field-glass, together with brown leather sword-belts, &c. But to take a wider field. I propose to deal shortly with a few, and only a few, points, touching the equipment of artillery, infantry, and cavalry, from the standpoints of utility, the comfort of the soldier, and economy both to the State and the individual. I cannot pretend to exhaust this large and important subject in one lecture, and, indeed, I cannot lay claim to the knowledge required to do so, even if I had that important element, time, completely at my disposal.

With your kind permission, then, I will proceed to the consideration of the equipment of artillery, the term "equipment" to include all articles required for the use of the soldier.

Artillery.

My remarks upon this branch of the Service must necessarily be brief, first, because the most important part of its equipment, namely,

Fig 8

Fig 4

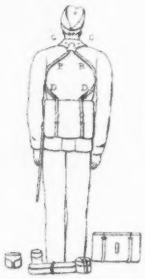


Fig 5

Fig 1.

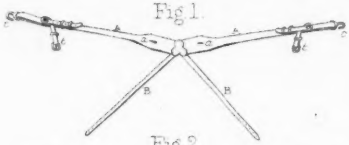


Fig 2

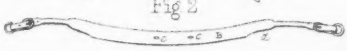


Fig 3.

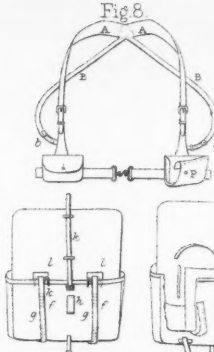


Fig 6.

Fig

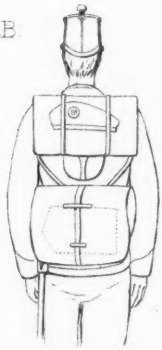
OLIVER EQUI

Fig A.

RICE'S

TROWEL BAYONET

Fig B.



WATER-BOTTLE ON HAVERSACK

FORAGE CA

FRONT

STRONG STEEL SPRING

CAVALRY

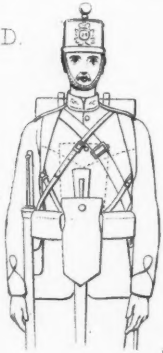
VALISE EQUI

Fig C.

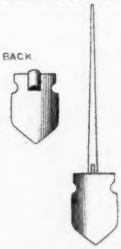
FOR TEMPORARY CARRIAGE

HANDLE AND BAYONET IN ONE FROG

Fig D.



SPADE READY FOR USE



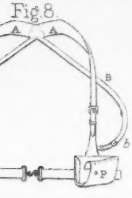
BACK

IN COVER

OLIVER ENTRENCHING SPAD

Harrison & Sons Lith. 3. Martins Lane W.C

Fig 8.



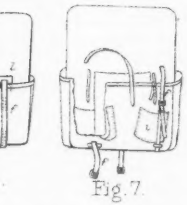


Fig. 7.

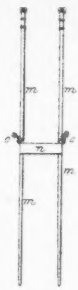


Fig. 9.

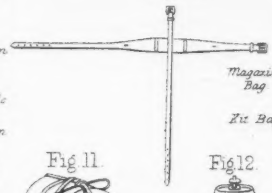


Fig 10.

Fig 11.

Fig 12.

Fig 13.

Fig 14.

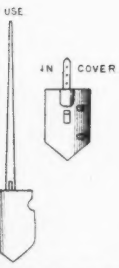
Fig 15.

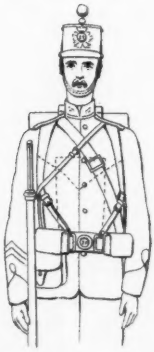
E Q U I P M E N T

Fig 16.

Fig 17.

E Q U I P M E N T.





ENCHING SPADE.

PRESENT EQU

Fig 1.

BRIGHTON EQ

Fig 3.

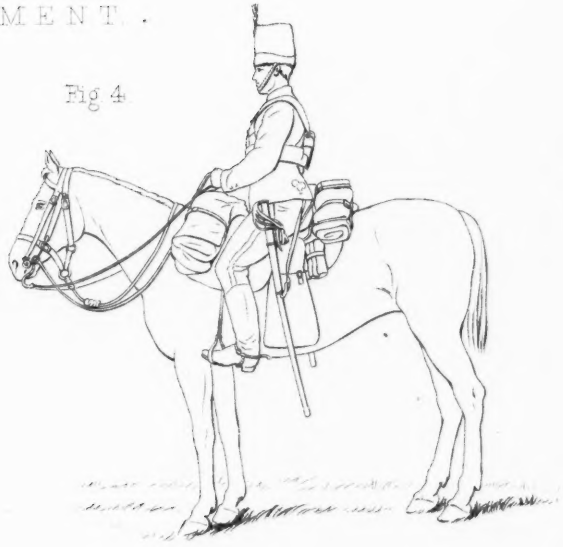
Harrison & Sons Lith. St Martins

EQUIPMENT.

Fig 2.

EQUIPMENT.

Fig 4.



Jones Lith. 9 Martins Lane W.C.

the g
posse
artill
the S
Mu
ject o
with
while
divisi
to th
shall
gests
rially
use sh
of an
wagg
horse
to be
weigh
Ellis'
upwa
servi
each
would
whetl
a wal
adopt
rapid
adopt
yet co
"one
by a
direc
autho
when
in the
have
when
have
per 1,
we co
I am
ment
one, a
settle
A f
defen
or cav
and c
which

the gun, demands an amount of technical knowledge which I do not possess; secondly, because the remarks concerning several articles of artillery equipment, &c., apply equally to that of the other branches of the Service under consideration to-day.

Much attention has been given within the last few years to the subject of the equipment for the supply of ammunition in the field; and, with a view to improvement in this direction, Major W. Ellis, R.A., while proposing to raise the number of guns attached to an infantry division from 18 to 24, and also that no guns shall belong permanently to the cavalry brigade, but that a brigade of 48 horse artillery guns shall be formed, from which guns shall be detached as required, suggests that the equipment for the supply of ammunition shall be materially altered. He proposes that the ammunition waggon in present use shall be replaced by two limbers, carrying together the same amount of ammunition as the waggon, and requiring no more horses than the waggon, namely, six; the first line of limbers to be drawn by four horses, which would keep up with the guns in action; the second line to be drawn by two horses, and to move as a rule at a walk. The weight of a waggon loaded is 40 cwt. 0 qrs. 2 lbs., whereas Major Ellis's limbers each weigh, when packed, 18 cwt., or, taken together, upwards of 4 cwt. less than the loaded waggon. Each horse in the service waggon carries or draws 747 lbs., whereas in the 4-horsed limber, each horse would carry 504 lbs., but in the 2-horsed limber each horse, would carry 1,008 lbs. The question among others to be solved is, whether or not this latter weight is excessive when moving as a rule at a walk. I am inclined to think not. Should Major Ellis's proposal be adopted, there would be greatly increased mobility, a more easy and rapid supply of ammunition in the field, and last, but not least, the adoption of such an alteration would be acting out the commonplace, yet common sense proverb that "It is better not to carry all our eggs in "one basket." When we consider the tremendous moral effect produced by a concentrated, well directed, and rapidly delivered artillery fire, directed and delivered in such a manner as, I am led to believe, on the authority of the latest experiments, only our British gunners can effect; when, moreover, we consider that Germany had 4 to 5 guns per 1,000 men in the army corps in their last war, and that Russia deems it necessary to have 4 guns to every 1,000 bayonets and 8 to every 1,000 cavalry; and when we consider that the adoption of Major Ellis's proposals (and I have by no means exhausted them) would raise our proportion to 3 guns per 1,000 bayonets, or 4 per 1,000 men in an army corps; when, I say, we consider these points, and the issues dependent on their right solution, I am sure I am not exceeding when I say that the subject of the equipment for the supply of ammunition in the field is a most important one, and demands a searching and extended investigation and an early settlement.

A few words with regard to the fire-arms, &c., used by gunners in defending themselves and their guns when attacked, either by infantry or cavalry, at close quarters. For the defence of each gun, its horses and complement of men, two carbines are supplied, the ammunition for which is to be maintained by drawing on the cavalry regimental reserve,

and on the cavalry carts with the sections of the army corps reserve. These carbines are carried with their sword-bayonets on the gun-limber, and, as a rule, are taken with the limber under cover when the gun is in action. The gunners with the guns are thus left with their side-arms to defend themselves and their guns from an attack at close quarters. Now the fact of their being supplied with such a weapon proves incontestably that they are supposed to expect such an attack, and to meet it as best they can with the weapon provided. Is this provision of carbines and side-arms sufficient for the purpose intended? Suppose the carbines with ammunition were always given to the gunners with the guns, and that the cavalry supply-carts were always so conveniently near that the supply of ammunition could be maintained, would they then constitute, with the 74 sword-bayonets in the hands of the gunners not armed with a fire-arm, an adequate defence against a well-delivered attack by cavalry at close quarters?

One thing we may safely say is this: such a provision never enters into the calculations of the attacking party.

Should, on the other hand, each gunner be given a six-barrelled revolver, taking guns, even by surprise, would be a much more dangerous game than under existing circumstances. Again, the man armed with carbine and side-arm has his hands full, and unless he lays the first-named aside, with the strong probability of losing it in the hurry of action, he is useless in working the gun; but take it and the side-arms away, and let the man wear the waist-belt only, and let him have a pouch for his ammunition and his revolver attached to the waist-belt behind his back, so that he can slip them both with ease from rear to front, and you have both his hands free to work unimpeded, and he has a weapon which can be used with considerable effect at close quarters.

With regard to the tunic, I cannot help thinking that utility and the comfort of the man are in too many cases sacrificed to appearances. As a rule, the tunics are made much too tight round the neck and chest to be comfortable in working, and I believe that if the tunic were cut in one piece from the collar to the bottom, as some of the native cavalry in India have them, it would last longer and look far better, as there would be no seam under the belt to wear threadbare and white, while the rest of the garment remained in good repair.

My remarks on the head-dress of the artillery being identical with those I have to make upon that of hussars, I pass on to the boots at present in use in this branch of the Service. I am informed that the gunner receives three pairs of Bluchers or ankle boots and one pair of Wellingtons in two years. Now, with regard to the latter, there are many, myself among the number, who have been led to believe that it is a most unworkmanlike article of kit.

At some athletic sports at Aldershot, I saw a tug of war between a team of as fine a set of gunners as one could well pick, and a team of an infantry regiment. I watched with interest for the result, because at that time I was trying to devise some improvements in military boots. I was not surprised to see the gunners slip down several at a time and in the end lose the tug, because they nearly all had on the

Wellington boot, having come to the games dressed in walking out costume, and when they pulled on the rope and turned sideways, their heels gave way and consequently their ankles turned and down they went. The same principle would apply in going over rough ground, or dragging guns, especially in mountainous country. Again the cost of the Wellington to the country is, as a rule, 16*s.* 10*d.* per pair, that of the ankle boot, 10*s.* 6*d.* Further, the cost to the man for new fronts to his Wellingtons, is 14*s.* 6*d.*, no small item out of a private's pocket. I have here a highlow made on an entirely new principle; the side seams, as you see, open to the rear and not as in ordinary boots to the front; rain hard as it may, no water or mud can possibly beat in and wet the foot; it fastens simply by a strap and buckle on each side, and when on, you cannot tell the difference between it and the Wellington; but in the one important point in which the Wellington fails, namely, support to the ankle, it succeeds. It is, moreover, lighter than the Wellington, and in the space taken to store 700 Wellingtons, you may store 1,000 of this class. Further, it costs the man less than half to repair, and the cost to the country would be 6*s.* 4*d.* per pair less than the Wellington; in other words, the Government would save 3*s.* 2*d.* per annum for every man so equipped. This boot has one serious disadvantage, viz., that the whole army of bootmakers and contractors would be against it, because it would deprive them of the profit on 3*s.* 2*d.* per man per annum. On the other hand the Wellington boot has an advantage which is considerable in the eyes of a small number of Officers who go in for appearances rather than for utility, namely, that the trousers fit over the foot with a few less wrinkles than it would with the other; but then who talks about the wrinkles at the bottom of an infantry man's trousers, although he wears a short boot in full dress?

In concluding my remarks on this branch of the Service, I desire to draw your attention to the fact that the various classes of artillery, whether heavy, medium, or light, are distinct, and that for the various duties connected with the guns, two distinct classes of men are chosen, the gunner as a rule is the heavy man, the driver is always chosen for his lightness in comparison.

This principle of "the right man being put in the right place" seemed to hold sway in the classifying of infantry from the earliest times, for instance, about 300 B.C., the Grecians had three distinct classes of infantry, heavy, medium, and light, equipped and armed according to their various characteristics. They fought in three lines, the light foremost, then the medium, and the heavy last; in the same way, at the time of the second Punic war, the Romans had four distinct classes of infantry; they also were distinct with regard to physique and equipment, and fought in three lines as the Grecians did, except that the fourth class, the lightest, fought between the legions.

Now, without going into the development of our own infantry from its earliest history, the fact remains that we have preserved three distinct classes of infantry in our Army, and no one can fail to notice the great differences which exist with regard to the size, weight, and

pace of the various classes in this arm in the present time, and on service the light would be used on occasions when the heavy would be useless, and *vice versâ*.

The progress made by other nations; the introduction of breech-loading rifles; the increasing value of artificial cover for the infantry soldier and other things, have drawn considerable attention to the equipment of this arm, and one cannot read of the results of past wars, and study the progress of the present war, and also ponder the possibilities and probabilities of the future, which future—for us, may not be very far off—without coming to the conclusion that some important and very material changes are necessary. The question which would naturally propose itself at the outset is this, "Have we kept "pace with the times, and altered our equipment to meet the require-"ments of modern warfare?" On careful consideration, I think the answer must be, that "If our pace is not quite that of the times, we "are pretty handy, and moreover, just now it is evident, from the "number of committees appointed within the last few years to consider "this subject, that we are going to quicken our pace considerably."

There are few but will admit that the Henry-Martini rifle now in use is in many respects a step in the right direction, but even it has some serious defects, most of which can be remedied easily: first, the length of barrel is insufficient; this makes the arm awkward when at the "order"; far worse, it takes away, to a considerable extent, its efficiency as a bayonet-carrier. It is no less than 10 inches shorter with bayonet fixed, than the Turkish weapon made in America at a cost of about £2 15*s.* or so, and called the Martini-Peabody.[1]

Another great defect in this arm is, I believe, the spiral spring in the breach action; the practical result of the adoption of this class of spring instead of the well-tried flat mainspring has been that to secure a 16 lb. blow a spring with a force of 40 lbs. had to be adopted; this led to an excessive strain on the scar-nose, and the introduction to obviate it, of another complication of the lock. I may remark that several examples of flat mainsprings may be examined which show that there is no difficulty in having a flat mainspring if desired.

Again the divided stock is objectionable; first, because the recoil is much more severely felt where the greater part of the shock is transmitted by an iron bolt, not indeed touching the heel-plate, but yet far from having the elastic movement of the whole old stock; secondly, when the stock of the Martini-Henry shrinks or expands from the effect of climate, a change by the armourer-sergeant in the curve of the guard lever becomes necessary, or the breech cannot be shut.

Again the distance from the toe of the butt to the trigger ought, as is well known to gun-makers, to be exactly 14½ inches, but this has been overlooked in the weapon under consideration, and the consequence is that the Martini-Henry has a misshapen stock, ill-adapted for good shooting when rapid fire is resorted to.

One other serious defect in this weapon is that the hold or grip of

[1] Having found that the information given me regarding the reduction of the charge for the Martini-Henry rifle was incorrect, I am glad to be allowed to withdraw unreservedly the remarks made by me on that point.—F. G.

the arm is entirely metal, and most inconvenient, in winter weather, in cold countries.

Some of the above defects are under consideration now, and it is, I believe, proposed to bring up the present total length to that which is deemed necessary by lengthening the bayonet. Would it not be better "to kill two birds with one stone," in gaining the required length by adding to the barrel, and thus be able to use the originally-intended charge of powder, and regain the good trajectory absolutely forfeited under present circumstances? This brings me to the cartridge now in use; it is a built-up one of greater weight than necessary by 10 per cent. (or 10 cartridges per 100), a very serious consideration. It is composed of various metals, and liable, as shown in India, to spontaneous decay in the magazines, from electrical action; it is, moreover, more expensive and less simple, as well as weaker than a stamped metallic cartridge.

Now, supposing the above-mentioned defects to be remedied, what then? Are we to rest satisfied with putting a good weapon in the man's hands? No! we must seek to place the man in such a position that, with safety for himself, he may bring his weapon to bear on the enemy with the greatest obtainable effect.

We must all admit that natural cover does not always admit of the above-mentioned conditions being fulfilled; it, therefore, becomes necessary to provide the man with the means of making artificial cover, the value of which is incontestably proved by the occurrences of past wars and of that now in progress. Our own action in the matter, together with frequently-expressed public opinion, shows that the importance of the subject is increasingly appreciated, but I am rather inclined to think that the equipment for the provision of artificial cover for infantry is supplied, if I may use the simile, in too homœopathic doses. I think allopathy is the system for the patient under treatment, for instance, in order to supply an infantry regiment, of 1,000 bayonets, with trenching tools in action, one cart (No. III in the circular of December, '77), weighing when packed 18 cwt. 3 qrs., and drawn by two horses, is allowed. Amongst other necessaries, this cart conveys 304 implements suited for entrenching purposes. Now, the manifest disadvantages of this system are, 1st, loss of time, an important element, in serving out the tools; 2nd, the number, when issued, is inadequate to perform quick work; 3rd, the cart cannot be in every place at the same time; 4th, it is liable to injury or destruction by artillery or other fire; 5th, many places where the regiment would be required to go would not admit of its following; 6th, it is liable to be lost, and there would be the trouble of the supply of forage for the horses and escorting.

I have here two inventions for intrenching purposes, one invented by Surgeon-Major Oliver, the inventor of the magazine equipment now under the consideration of the authorities; the other, the invention of Colonel Rice, of the American Army. The latter has undergone a thorough trial, in actual service; the former has not, I believe, been submitted as yet to His Royal Highness the Field-Marshal Commanding-in-Chief, and is, in one sense, therefore, untried. Colonel Rice's invention is an amalgamation of the bayonet and trowel, and each man

carries one; it is light, and but little more expensive than the old bayonet, and about the same or less expense than the sword bayonet in present use.

Bear with me whilst I give you a few interesting facts touching its trial.

General Miles writes:—"As a trowel it has been severely tested under "my immediate supervision. A company in single rank, working in "a soil of medium hardness, threw up, in the space of ten minutes, a "work along its entire front of sufficient height and thickness to pro- "tect a line of battle. The work was tested, and found to be bullet- "proof against the Springfield breech-loader; at a distance of 20 "paces the balls would not penetrate half through the work. As a "bayonet, I believe that it is as formidable a weapon as the one now "in use, and that as severe a wound can be inflicted with it. Also its "moral effect in a charge would be as great as that of the old one." The Small Arms Committee report that "Three men formed a breast- "work 5 feet long, 3 feet thick at bottom, 1 foot thick at top, and 19 "inches high, in 4 minutes. The soil was very hard, not having been "disturbed for over 20 years, besides being full of roots, &c." In the second trial, in easier digging, they cut a trench 6 feet square, and made a parapet similar to the above, and when lying down in the trenches, they could not be seen at 10 paces distance. "This," continues the report, "is making cover in a much less period of time than entrenching tools "could be ordered and brought up from the rear to the front of an "army." The following is a resolution of the Board appointed to report on it:—"Resolved: That the Board recommend to the War "Department that the Rice trowel-bayonet be adopted for the use of "the military service." The Board was composed of a number of Officers of high rank, as well as one or two of junior rank, in the American Army. The Ordnance Office thereupon advised the Secretary for War to issue 10,000 of Rice's trowel-bayonets. He did so, and, in the campaign of 1876, on the Yellowstone, according to the report of the General in command on that river, "The men made great "use of it in cutting sticks to put up their shelter-tents at night, as "hatchets, for digging a small trench round their tents, and in cutting "their meat, digging for water, &c." Again, the Commander-in-Chief, writing from Dakota, says, "The experience in this campaign "of the troops who are supplied with the trowel-bayonet shows it to "be invaluable. It also deserves the name of an universal tool. In "my judgment, every infantry regiment in the Service should be "supplied with it." Now, these are facts and opinions founded upon fact with regard to the above-mentioned weapon. The fact that a whole line of infantry can be put out of sight in an average time of six minutes, and that in a trench with a parapet in front which is impervious to bullets fired from breech-loading rifles at a distance of only 20 paces, speaks volumes; further, the fact that the man carries the implement himself, without any increase of weight, thereby doing away with the need of the cart now used for its conveyance, and freeing the cart-horses and driver, as well as part of the escort, to be used for other purposes, also speaks volumes, because the man is then able,

the moment the word "halt!" is given, to set to work, without loss of time, and make cover for himself. The disadvantages accruing from the adoption of the regular spade-form of trenching tool for each man may, to a limited extent, be seen even before experiment; first, the soldier would have to carry 3½ lbs. to 4 lbs. extra weight; there would be a loss of time in detaching and fitting and then in unfitting and attaching again; and also an extra expense to the country. The advantages would be that the implement could accomplish more work if the men did not get in each other's way, owing to its size and length, and that it acts, when adjusted according to Dr. Oliver's proposal, as a shield to a very vital part of the man's body. The latest instructions published by authority on this matter, that I have been able to lay my hands on, and which are imparted to the students at all garrison instruction classes, show that men at an interval of about 4 feet can make a trench, with the larger tools, 7 feet wide and 1¼ deep, with the requisite parapet, in 50 minutes, taking the mean time laid down. I think, therefore, that there can be no two opinions as to the result of comparison between the trowel-bayonet system and our present system from this point of view.

A military correspondent of one of the daily papers wrote some little time back to the effect that the trench dug by the Turks was a better trench than that in vogue amongst us, because it was made 3½ feet deep instead of 1½. Now, an essential feature in a good trench is, that while it gives sufficient cover to the defenders from the fire of the enemy in front, yet, if they are driven out by the enemy, it shall not afford him sufficient cover from fire from the rear. I think that one of the causes of the many failures of the Turks to retake the entrenchments captured from them, was that their trenches were so deep that they afforded good cover either way. Our American friends lay more stress on the moral effect than on the actual effect of the bayonet; and, perhaps, they are right when we consider the statistics of the causes of the casualties in the Franco-German war as supplied by the Germans; they were as follows:—95 per cent. from the bullet, 4 per cent. from artillery fire, and only 1 per cent. from sabre, lance, and bayonet combined. If, therefore, the moral effect be retained by the adoption of a trowel-bayonet, I think the actual effect will, to a certain extent, take care of itself.

I hold in my hand an invention by Admiral Selwyn, in which, without extra weight to the man or gun, a good trowel is provided which fits into the stock of the gun which is hollowed out for its reception. The great advantage in the eyes of many in such a system would be that our sword-bayonet would be retained, and that the man would have an efficient tool for trenching without increasing the weight of his kit.

It has been more or less generally felt that the present mode of carrying the man's kit is too cumbersome, and that with it he cannot carry sufficient ammunition to meet the requirements of modern war, the outside limit of what he can carry, being only 70 rounds, or for a regiment of 1,000 bayonets 70,000 rounds. The means also for attaching it to the body are much too intricate.

Surgeon-Major Oliver has attempted to meet the need by an invention called the "Magazine Equipment." I think it is fitly so named as it makes every man his own magazine, and with regard to ammunition, food, clothing, and waterproof sheet, it makes him quite independent of the base of supplies for 24 hours. This equipment is, as you see, very simple in design, and will, if adopted, relieve the man of a great many encumbrances in the way of straps, ballbags, haversack, &c., which now interfere with the free manipulation of his rifle and trenching tools. The chief parts are two bags for kit, the lower one, as a rule, is left in the barrack room in time of peace, except when marching from one station to another, and in time of war is left at the base of supplies. The great coat is taken out of the top magazine bag which is then placed on the belt, and the coat is hung on the shoulders. The magazine bag contains a day's rations, waterproof sheet, and 100 to 150 rounds of ammunition, which is conveyed to the expense pouch in front of the man by simply bringing the magazine bag from rear to front, which, as you see, the man can do with ease and comfort to himself. Another great advantage in this mode of equipment, is that the man can march at ease with open belt without fear of the kit falling off or being disarranged. He can, moreover, get at any thing he wants without help; moreover, the whole kit is more compact and rests nearer the centre of gravity of the body; further, it does not cover the whole back, and so allows a free passage of air. I beg now to draw your special attention to this fact, namely: that a regiment of 1,000 bayonets equipped in this kit, can, without extra weight, and with greater personal convenience, carry no less than 72,000 rounds of ammunition, more than an equal number of men equipped in the valise equipment in present use, together with the three ammunition supply carts attached to an infantry regiment. Add to the "magazine equipment" the trowel or trowel-bayonet, and you eliminate one cart weighing 18 cwt. 3 qrs., at present used to carry the required entrenching tools. (For full particulars see Appendix.)

With regard to the head-dress of the infantry, I am sure that the regiments which have been, and are to be supplied with helmets instead of the hideous shako, are to be heartily congratulated, as a more useless, ill-shaped, and, as regards sunstroke, dangerous article of equipment could scarcely be contrived. I feel sure that next year's manœuvres, if there be any, will prove incontestably the wisdom of the change. Contractors are, however, inclined to increase its height.

A word or so about the tunic. At first it was made so tight that a man seemed as though he could scarcely do more than walk straight to his front; later on they were made rather looser, and in 1854 still more so; but now I fear that comfort and utility are sacrificed on the altar of appearances in many regiments in this matter. It is a great mistake to think that a tunic cannot be made smart and comfortable as well, and that therefore it must be made very tight. With regard to the making of the tunic, the remarks touching the artillery tunic apply equally here.

I cannot pass from the subject of infantry equipment without drawing attention to the boot now in general use in this branch of

the Service. The complaints with regard to this article of kit are loud and general. Some of the disadvantages it is said to possess are, 1st, that after it is in wear some little time it becomes very unsightly through the gaping of the seams to the front—that the seams thus let in water, dust, and mud freely, and give, as a natural result, many sore feet. The man has to keep up laces, and these rot when often wetted. Again, when the men are in camp and have to march early in the morning, it is difficult for them to fasten the boot on properly owing to the small size of the lace-holes. Now, with this new boot no seams show to the front at any time during wear; when on it looks like a Wellington as far as neatness goes, and is easily taken off or put on by means of this simple buckle and strap, and the need of laces is done away with. As far as storing these boots goes, they can be stored in exactly the same manner as the boot in present use, and cost the same money. This is a boot I had in wear nearly two years at Aldershot and Hounslow (Fig. 21, Plate VI). It was worn through the heavy snows of 1874 and 1875, and has, as you see, had but little done to it in the way of repair. I wore it without the aid of the buckle in plain clothes as well as in uniform.

In speaking of the equipment of cavalry, it is not my intention to detain you long by tracing the various and most interesting changes that have occurred with regard to this branch of the military service; enough to notice the crisis that was reached upon the invention and introduction of gunpowder. It was then thought necessary to introduce by degrees fire-arms into the cavalry arm, thus they were often, to their great discomfiture, pitted against infantry. Then, in the early part of the sixteenth century they were intermingled with infantry, and the pace of the charge was reduced to the trot; the result of such a formation was, of course, not satisfactory. Colonel Denison remarking on these and other attempts to bolster up the waning use of cavalry against infantry says, "these facts all serve to show how "completely the soldiers of that age misunderstood the real value and "uses of a cavalry force, and how completely the invention of firearms "had upset the whole principles of warfare."

For a long time there were in existence two classes of cavalry—the heavy, which were more or less independent of infantry or other troops, and the light archers, who were included for tactical purposes with the gensdarmes, but who were banded together for these purposes in 1494, when Charles VIII entered Rome.

To come at once to our own cavalry: we now have three classes of cavalry in our Army. They are generally called heavy, medium, and light, and no doubt the heavy and medium fulfil to a certain extent the requirements which their names imply. But what about our light cavalry? Does it do so? I fear the line of demarcation between our medium and light cavalry has been trodden down to a great extent.

When we consider the important duties which cavalry, especially light cavalry, has now to perform; when we think that the safety of an army is to a very great extent dependent on the information concerning the enemy's movements that its cavalry provides; and, in the

second place, when we think of the importance of hiding from the enemy the movements, dispositions, and numbers of the army to which it belongs, to say nothing of obtaining information concerning the country to be passed through, and that in performing these necessary duties it may have to cover a great amount of ground at a rapid pace, should not this branch of the cavalry arm be horsed, manned, and equipped, in such a way as to fulfil the term "light" to the very letter?

Let us see what the hussar was in 1802, and then compare him with what he is now.

On referring to Charles James's "Military Dictionary" of 1802, we read that the hussar was dressed in a fur cap—a very different thing from the instrument of torture we at present wear—a jacket, breeches, and boots; they were armed with a crooked sabre, pistol, and carbine; he says, "their equipage is so light, and themselves such "excellent horsemen, that no other cavalry can pretend to follow "them." What is the case now? The average weight of the hussar on service now, including ammunition, forage, and ration, and deducting articles of kit left behind, is over 19 stone. The average weight of the men in my regiment who would go on active service to-morrow is 11 stone—the average weight of the whole regiment, including boys and the last joined recruits (a spare lot, as a rule), is 10 st. 7 lbs. The weight of their equipage brings up the total to the above-mentioned figure, 19 stone. Look on that picture and on this. There are many men in the hussar regiments who would make first-rate life-guardsmen, and very many who would make good lancers, and there are some lancers who would make good hussars, as far as weight is concerned.

Compared with the Austrian hussar, in 1873 or thereabouts, taking the weights of the horse, man, and equipment together, our hussars weighed 120 lbs. more, man for man. The French dragoon only weighed 70 lbs. more than our hussar, and the Prussian lancer weighed only 30 lbs. more. Since then, I believe, our equipment has grown heavier, and the men enlisted as hussars are bigger; and last, but not least, the horse meant to carry them is of a much inferior class.

I believe that horses for military purposes are becoming more scarce every year, and that the present system of supply requires considerable modifications.

When we consider what the horse for light cavalry is expected to do, I maintain that this question calls for very grave consideration. Many, whose opinions are entitled to respect, believe that our horses are bought too young; one disadvantage of doing so is, that a horse has all his baby sicknesses before him; and I am informed that in this country the loss through these is about 3 or 4 per cent.; further, it is a year before he can be used in the ranks, and this takes away a man per horse from general duty and parade work in order to train and attend on him. The present price paid for a trooper is 40*l*., and the usual age at which they are bought is rising four; so, at the rate of 1*s*. 9*d*. per diem for food, by the end of one year the horse costs the

Government 71*l.* in round numbers. I, among many others, believe that if the price were raised to 60*l.* or 65*l.*, and horses bought a year or two older, great benefit would be obtained, but then this would be merely a palliative measure, it would not strike at the root of the disease; and there are causes at work now in the country which, before long, will so aggravate the disease that the cure will be very costly; the country is being overrun with a worthless, unsound class of stallion; and, owing to the low rate charged by the owners, farmers who sell to the recognised buyers for military purposes prefer to patronize them, so that it does not pay a man now, as it used to do, to keep a good horse for the purpose under consideration.

How does the case stand now? The war strength of a cavalry regiment in horses is 480 troop horses and 44 for draught purposes. Suppose fifteen cavalry regiments were ordered abroad within six weeks, we should want for each regiment 120 to 164 horses; and to obtain say, to take about a mean, 2,000 horses, we should have to draw upon the second line to an alarming extent. Then comes the difficulty of filling up the gaps caused by death, loss, lameness, sore backs, &c.; and further, the still greater difficulty of filling up at once the ranks of the second line, and of establishing a reserve; this would require many thousands of horses within a short space of time.

Turkey wanted 3,000 horses the other day, and could not get them, "For" (the question of neutrality put aside for the moment) to use the words of Mr. Tattersall, "we have not got them to spare, and may "want them ourselves, and if we get them at any price, shall have to "pay a high figure for an inferior animal." He further asserts in his letter to the *Standard* of the 22nd December, that, out of 2,000 horses required for last year's manœuvres, 1,500 to 1,800 came from abroad.

I believe there never was a time when we needed so much to look this question straight in the face as the present; and I believe that the only cure must be found in the establishment of regular studs, on the same principle as those of Russia, Germany, Austria, and France. Mr. Tattersall, in supporting this view, asserts that the result would be to "have a good supply of the right sort of horses when required, "and at a cheaper rate."

I am inclined to think that our horses are, as a rule, very faulty in front of the saddle; and, considering the great weight they have to carry, the great height at which the kit is at present adjusted, and the long distances they may have to travel, I think that the horse needs to be particularly well shaped about the forehand. This brings me to the saddle in present use. Much attention has been given of late years to this subject, but no definite result has been attained as yet.

The manifest defects of the present saddle are, that the kit is carried too high off the horse's back, and when the man is mounted and the girths loosen, and when the man becomes tired, there ensues such an amount of sway that a sore back is the infallible result; further, the man's bridle hand is forced into a most uncomfortable position. The panels require constant re-stuffing, another fruitful cause of sore back; lastly, the weight of the whole kit is borne by the saddle.

With a view to remedy the above defects, Captain Crichton has invented a saddle and numnah which are undergoing a searching trial in several regiments. He has kindly placed one at my disposal to-day; you see the saddle carries the man, his arms and shoe cases only; the numnah carries the cloak and kit, and they are independent one of the other. The numnah is made of leather underneath next to the horse's skin, then comes a layer of felt and then one of canvas; the straps are fastened by means of rivets to pieces of sheet steel in front and rear between the canvas and the felt, and these pieces of steel keep the numnah up so that it shall not press on the withers or back; the numnah, besides carrying the kit, now takes the place of the panels, and it has no stitches on the side next the horse. The advantages this combination gives are, that the weight of the whole mass is distributed in three places instead of one. The whole kit is lowered about seven inches, which prevents the top-heavy rocking motion so apparent in the saddle in present use. The kit takes very much less time to clean, as the numnah keeps every article from touching the horse's sides, and there are fewer buckles and straps, and, as these latter are conveniently placed, the kit can be turned out in considerably less time than can obtain under existing regulations and equipment (Plate VII).

The blankets for man and horse can be carried, if necessary, between the saddle and the numnah without danger of shifting or becoming wrinkled, or allowing dirt to accumulate, as the numnah would still be next the horse's skin. The crupper and breastplate can be dispensed with, as the numnah adjusts itself to the shape of the horse's back; also, this saddle not having the rounded sideboards projecting in front, but being shaped like a plain saddle, does not shift forward. It is considerably lighter than the saddle in present use.

The numnah can be equally well made without the leather and with the felt next the horse's skin, it being still a moot point which is best. (For further particulars see "Crichton" in the Discussion.)

We must now consider the question of armament for cavalry, and when I think of the small number of cavalry we possess compared with that belonging to the Continental Powers, I am reminded of the causes which forced Alexander the Great to stop short at the Oxus, the cause of the annihilation of the glorious army of Persia under Darius in Scythia, the cause of the disasters which befell the legions under Marc Antony and Crassus at the hands of the Parthian light horse: I am led to ask, why was it that Richard Cœur de Lion failed against the hosts of Saladin? Why was it Napoleon failed against Russia? had the famous Cossacks nothing to do with it? What was it led to the defeat of such great men and great armies, but the want of more of that very arm which formed so important a part of the armies against which they were pitted? These and other considerations lead me to believe that our small force of cavalry should be armed and equipped far better than those of our neighbours, and that the men, horses, and equipment of our light cavalry should receive very special attention, for, to quote the words of General Sir Charles Napier in his "Defects, Civil and Military," "hussars our men are

"not: a real hussar, including his twelfth part of a kettle, does not "weigh twelve stone."

It has already been remarked that the first crisis which brought about great changes in the use of cavalry against infantry, was the introduction of powder and fire-arms; now the second great crisis was, in my opinion, reached on the introduction of the cilindro-conoidal bullet, together with improvements in breech action, which now make it necessary for a body of cavalry to run the gauntlet of ten shots to one that they risked in the time of Frederick the Great or of Napoleon. The manner in which infantry in square simply marched through cavalry armed only with sword and lance at El Bodon, Fuentes d'Onor, Crâone, and Rheims, and other instances, when the infantry were armed with the flint lock musket of short range, proves that cavalry to act effectually against infantry must be armed better than at present. Notice again what cavalry effected against infantry during the American War, now checking all three arms for a whole day, as at the battle of Five Forks; again, coming up with and engaging the enemy's rear-guard, while a considerable portion went beyond and took up a strong position, dismounted, and then finally inflicted very severe losses and took 6,000 prisoners and 16 guns. Again, see how cavalry dismounted, although ridden over, finally defeated their mounted opponents at Okolona, where Forrest's dismounted men were charged by three lines of Federal cavalry, but succeeded in repelling them; a fourth body of Federals then broke his line and got among his men, who at once took to their revolvers and shot down a great number and took many prisoners, and, finally, those who did succeed in getting through were discomfited by the reserves.

The question now is, what is the best armament for our cavalry? I answer at once that it is my firm belief that the front rank of all regiments should be armed with lance and revolver, and the rear rank with sabre and carbine.

Permit me to bring to your notice the opinions of others, also a few facts from history, and the action of other Powers in Europe. With regard to *les armes blanches*, this is no new idea, for Cromwell, describing the Battle of Dunbar, writes: "But here on the right, "their horses with lancers in the front rank, charge desperately and "drive us back across the hollow of the rivulet." Again, in March, 1828, the Emperor of Russia ordered the lance to be used in the front rank of all regiments then about to engage with the Turks, moreover, it has been in vogue for a long time in some of our irregular cavalry in India.

The lance is the best weapon to bring first to bear on the enemy, but it is no use in a *mêlée* and must be supported by the sabre. This is proved by the fact that, at the Battle of Aliwal, when the 16th Lancers broke into the Sikh squares, they were cut down right and left by the Sikhs who had put down their muskets and taken to their swords. The casualty-return of January 29th, 1846, speaks volumes: it runs thus:—"Cavalry—first brigade—H. M.'s 16th Lancers, "2 European Officers, 56 men, 77 horses killed; 6 European Officers,

"77 men, 22 horses wounded; 1 man, 73 horses missing." This gives a total of 8 Officers, 134 men, and 172 horses placed *hors de combat* in one fight.

Sir Hope Grant was not caught thus, for at Meangunge the 9th Lancers charged, supported immediately by the 7th Hussars and Irregulars, who cut down 500, and took 400 prisoners.

Nolan says, "All seem to forget that a lance is useless in a *mêlée*." Marshal Marmont in his "*Esprit des Institution Militaires*:" "It "would be better for cavalry to have both the lance and sabre " . . . . the lance should be the principal weapon, and the sabre "an auxiliary arm." Jomini says, and his utterances are clear and to the point: "In charges in line the lance is very useful; in *mêlées* "the sabre is much better; hence comes the idea of giving the lance "to the front rank, which makes the first onslaught, and the sabre to "the second rank, which finishes the encounter usually in individual "combats. The lance is the best arm for offensive purposes when a "body of horsemen charge in line, for it enables them to strike an "enemy who cannot reach them, but it is a very good plan to have a "second rank as a reserve armed with sabres, which are more easily "handled than the lance in hand-to-hand fighting, when the ranks "become broken." De Brack also calls special attention to the necessity of supporting lancers by swordsmen.

With regard to fire-arms, Trower writes in his "Hints," that there should be 10 carbineers to 50 lancers—this is an advance in the right direction. Hozier, in his "Seven Weeks War," when speaking of an axiom applying to cavalry, says, "But it no longer applies since the "introduction of breech-loading rifles. The *morale* of cavalry will not "be affected if lancers are properly instructed as to the use of these "arms." The use Sheridan made of his 10,000 horsemen, when dealing with General Lee's rear-guard on the way to Lynchburg, is very striking, but then they were thoroughly instructed in the use of these arms, and, as noticed before, were the means of 6,000 prisoners being taken, together with 16 guns and 400 waggons. This was effected against cavalry, infantry, and artillery combined, and with the advantage of a well-chosen position. The determination come to, therefore, by His Royal Highness the Field Marshal Commanding-in-Chief to give our lancer regiments a breech-loading carbine which will be effective up to 800 or 1,000 yards, places them in a position to act in a like manner when occasion presents itself. The late wars prove conclusively that, except under the most exceptionally favourable circumstances, cavalry should not attempt to charge bodies of infantry. The four charges made by the French light cavalry at Sedan is a case worth noticing in support of this view, and again when at Plavigny, near Vionville, General du Preuil charged the Prussians and lost in a few minutes 22 officers, 208 men, and 243 horses, and the Prussian infantry did not lose a man.

Now, with regard to cavalry being opposed to cavalry, I would remind you again, that the casualties during the Franco-German war stand thus: 95 per 100 from the bullet, 4 per 100 from artillery, and 1 per 100 from lance, sabre, and bayonet, combined. In November,

1864, a fight took place in Virginia between a squadron of Federal cavalry armed with the sabre, and a squadron of Mosby's, armed with the revolver; the loss of the latter was 1 man killed and several wounded, and the loss of the Federals was 24 men killed, 12 wounded, and 62 prisoners—36 killed and wounded out of 100. In a similar fight, the sabres lost 26 killed and wounded, 54 prisoners, and 80 horses, the Confederates, who were armed with the revolver, lost not a single man.

On the other hand, in 1799, at Egmont-op-Zee, two troops of English cavalry charged 500 French and drove them off; the French rallied and charged again; however, the result of both mêlées was the loss on the English side of 3 killed and 9 wounded. Similarly, out of 65,160 killed on the German side in the war with France, 218 only were killed and wounded with the sabre and clubbed musket. The killed by the sabre in the whole six months' war, including Woërth, Vionville, and Sedan, together with the battles on the Loire and the northern provinces, as well as all the outpost service, extending over nearly half of France, was six, notwithstanding that there were 40,000 men engaged. What does Sir H. Havelock say about the American cavalry? "The practical experience of nearly four years of continual "war, the entire and untrammelled confidence placed in good men "amongst the Northern leaders, when they proved themselves to be "so, and the complete freedom left them of devising and executing "the improvements their daily experience suggested, had enabled "Sheridan, and one or two more of similar bent of mind, to shake "themselves free of the unsound traditions of European cavalry "theory, and to make their own horse, not the jingling, brilliant, "costly, but almost helpless unreality it is with us, but a force that "was able, on all grounds, in all circumstances, to act freely and "efficiently, without any support from infantry."

What were the best cavalry in the eyes of Napoleon? He held that the Poles and Cossacks were the best light cavalry in Europe. How were the former armed and equipped? Roemer, in his "History of "Cavalry," says, "At its reorganization in 1817, the Polish army con- "tained both heavy and light cavalry. The former consisted of 144 "companies, half of which, armed with lances, formed the front rank, "while the other half, armed with carbines, formed the rear. Each "man had also sword and pistols. This heavy cavalry was further "divided into husarz and paucerny." He futher says, concerning the light cavalry, "They wore no defensive armour, but in other respects "were equipped like the heavy cavalry."

With, therefore, such conclusive evidence before us, with such a host of opinions of men of vast experience, must we not conclude that the best armament for our cavalry all round is lance and revolver for the front rank, and sabre and carbine for the rear rank. No regiment ever has more than about one-third of its carbines in use at the same time, and therefore it is superfluous to arm with carbine all round; whereas if all the best shots (and I believe the prizes for shooting ought to be doubled) were put in the rear rank, and were mounted on the quietest horses, I believe the end required would be attained, and

that without extra expense. In concluding my remarks on this point I will only add, that I think that the fact of Russia having adopted this plan for a long time back, and that since the Franco-German war, Prussia, Austria, and Italy also, have begun to do so to a great degree; these facts, I say, ought to have considerable weight with us who possess such a small force of cavalry, and who ought, therefore, to equip them in the best possible manner.

One word with regard to the busby. In its present shape it is a mere parody on the original, which was simply a band of fur, with the bag hanging over the side; a small cock's feather was also worn. Now, it is so high off the head that it forms a regular catch-wind, and being hollow at the top, it also makes a very efficient rain-trap. A further serious disadvantage it possesses is, that when brought in damp, with the perspiration of the man's head, as well perhaps as with the rain, it is put in a bag and hung on a peg, and thus the brow-band contracts and causes great pain to the man, especially when riding against the wind. Further, it is no protection against the sun at the back of the neck. This helmet (*pointing*) would have the advantage in looks, comfort, and utility, for it gives good cover to the eyes and back of neck, and further, would last five times as long.

The cavalry tunic is made in many instances too tight, and I believe it ought to be made in one piece from top to bottom. Now that the stable-jacket is, fortunately for the comfort and pocket of the soldier, a thing of the past, he requires some sort of undress jacket in which, as a recruit, to attend riding-school, foot drills, and fatigue work. If he has to do all these duties in his tunic, it will not be fit for much a short time after issue. The jacket at present in trial in several regiments of cavalry, as well as in the artillery, has not, I think, much chance of finding favour in the eyes of the Officers of the corps in which it is being tried, with the exception perhaps of the 17th Lancers, because it is, as a rule, so badly cut. The jacket which I had the honour of submitting to His Royal Highness the Field-Marshal Commanding-in-Chief some two years ago was a well-fitting, smart jacket, and the 17th Lancers have kept to it as nearly as possible, but those issued to the Artillery are more like a very badly-shaped tunic, while those issued to the 7th Hussars, although I believe the Commanding Officer is in favour of them, might be made much smarter, with the simple and inexpensive addition of a scarlet collar, and perhaps scarlet piping, which would take away the general idea of plainness they give at present.

One great instrument of torture to the soldier is the sword-belt. After a long ride the pressure on the region of the colon, kidneys, spleen, and lower part of the liver becomes almost unbearable. I have here an idea which, carried into effect, would, I trust, do all that the sword-belt is required to do, and that without any discomfort to the man, and with great saving to the country.

By it, as you see, the sword can be hung from the shoulders, the proper place, and not from the waist, the left shoulder bearing the weight of the front sling, and the right shoulder bearing the back sling. This can be effected by a very simple alteration of the braces

in present use. I cannot pass from the question of hanging the sword without saying a word about the sabretache: a more useless and inconvenient, as well as unornamental, article of kit does not exist. The man never carries despatches in it, it trips him up when dismounted, and stops him when going through underwood; further, there never is a mounted parade but some have to be repaired, having been torn in wheeling, &c., &c. If it were abolished, the country would save a considerable sum of money. Again, in its present shape, it, like the busby, is a complete parody on the original; it was worn several inches higher, and had the opening outside; further, the Lancers discontinued its use in 1854. The adoption of the above suggestion would, besides saving money to the country, give the man more comfort at his foot drill and riding school; but it would not go to the root of the matter in the question of dismounted work on active service; the sword should then be fixed on the saddle, and then the man would be able to act with much greater freedom, and as a natural consequence with greater effect.

Another cause of discomfort is the method in vogue of carrying the water-bottle: this, when filled, weighs somewhat under 3 lbs., and is carried behind the right elbow on the hip, and slung from a narrow strap passing over the left shoulder. Thus it not only positively hurts the man when moving at the trot and canter, but prevents his getting quickly at his pouch. A very simple, and I think effectual, way of meeting the difficulty would be found by adopting this plan, whereby the strap is abolished and the bottle taken out of the way of the pouch, and leaves room for the revolver to be carried in a manner similar to, but not identical with, the American fashion, with the further advantage, should the revolver be so carried, of ensuring to the man an effectual weapon when, by any accident, he may become separated from his horse and carbine. The present havresack is simply divided down the middle by a line of stitching, so that the man can carry his provisions in one side and his tobacco, &c., in the other; the bottle then slips on a leather loop by a strong clip, and will not then hurt the man's side (Fig. 19). The objection to carrying the bottle on the right side gained ground to such an extent that some regiments actually adopted the plan of carrying the bottle on the saddle. The objection to this system is obvious, for the water being meant for the man and not for the horse, let the man be wounded and separated from his horse he loses that very thing which he then so much needs.

One great need in our service is a good method of hobbling our horses in camp; this is an invention registered by Mr. Pallin, V.S., of the 20th Hussars, by which it becomes impossible for the horse to get loose without breaking something. It costs more than those in present use, but it is wiser, I think, to pay a little more for an article of the kind than to lose a number of valuable horses once in a way.

I am informed that it is under consideration whether or not to do away with the Wellington boot for cavalry. Certainly to relinquish it would be to confer a boon on the man and on the country in the way of saving expense, but what will be the substitute? If the man wears his jack-boots always it will entail enormous expense to the country,

because they would have to be issued oftener, and they cost from 1*l.* 1*s.* to 1*l.* 6*s.* Again, the man would find them most uncomfortably warm in the summer months, besides which, by continual wear, they soon would lose their shape, and would cost the soldier much more to repair than even the Wellington. By the introduction of this boot already noticed, we could combine the highlow and Wellington to a very great extent, and so keep the smart unstrapped overalls for walking out and dismounted work, and thus would also consult the comfort as well as the appearance of the soldier.

I must heartily thank those Officers who have placed their inventions at my disposal to-day, and I also have to acknowledge my indebtedness to the Secretaries of this Institution for their kind help in pointing me to the various sources of information. Further, I have to thank the Assistant Adjutant-General, Colonel Baker, who not only gave me information on various points now under consideration, but generously placed at my service several articles of equipment.

In closing my remarks, allow me to draw your attention to two letters written by Her Most Gracious Majesty the Queen at the time of the Crimean War. One written to Lord Raglan runs thus: "The "Queen earnestly trusts that the large amount of warm clothing sent "out has not only reached Balaclava, but has been distributed." Again, in writing to Lord Panmure on the subject of the men's huts, Her Majesty says: ". . . . there would be no difficulty in obtaining "the money requisite for the purpose, so strong is the feeling now in "the public mind for improvements of all kinds connected with the "Army and the well-being and comfort of the soldier." I have only to remark that the time of the sore and cruel need which gave occasion for the writing of those kind and heartfelt letters was not the time to find out that the coffee brought actually to the spot for the men's use was not even roasted, that the poor fellows' coats were made of such stuff that they rotted off their backs, and that their boots were so badly put together that they fell in pieces off their feet. That terrible tension of the public mind need never have been created; Her Majesty the Queen might have been spared many a bitter night of harrowing and heart-breaking anxiety on behalf of her faithful and patient soldiers, who were dying by hundreds from absolute hunger and exposure, had the evil spirit of "Let us alone, we are as well off as our neighbours," not been in existence, and had the spirit which now obtains in the highest military quarters then found free course, which spirit, I am thankful to believe, pervades to a great extent the mind of that portion of the British public who are interested in our Army, and which finds expression in the words I now take for my text, namely:—

"Prevention is better and less costly than cure."

Appendix.

OLIVER'S MAGAZINE ACCOUTREMENTS.

The accoutrements in which my invention is comprised are composed of two braces—magazine brace, and kit brace; two bags—the magazine bag and kit bag; a magazine pouch, a water-bottle, a coat yoke, a mess can, and a waist-belt and frog.

The device termed "magazine-brace" is adapted for cavalry use; and when so used is provided with a cavalry cartridge-holder.

The more prominent portions of the accoutrements are the two braces and the two bags.

My improved accoutrements enable the soldier to carry his kit, a large amount (as much as two hundred rounds) of ammunition, his day's rations of water and food, a canteen, a waterproof sheet, and great-coat. At the same time they dispense with necessity of all cross belts or straps in front of the chest, the present valise bag and ration bag, and all ammunition pouches or ball bags, except one small one, capable of holding thirty rounds of ammunition.

The nature of my invention, and the manner in which the same is, or may be carried into effect, will be understood by reference to the accompanying drawings, which I shall now proceed to describe.

All the straps and braces of which accoutrements are composed are to be made of good bridle-leather, thinned down where necessary, for the small straps; and to be of moderate thickness for the two principal ones, viz.:—the "magazine brace," and "kit brace."

The magazine brace is shown in Fig. 1, and is composed of one main and two side straps. The main strap, A, is fifty-six inches total length from tip to tip when the ends are unbuckled. Its neck or centre part is six inches by two deep, and is shaped to fit the lower part of the back of the neck. The side straps, B, are three-fourths of an inch straps, each twenty inches long, and perforated at the free ends with six holes, each three-fourths of an inch apart.

In the centre part of the main strap are two button-hole slits, *a*, five inches apart, for the iron loops of the kit brace to pass through. External to this point the magazine brace begins rapidly to decrease in width, until, at the distance of six inches more from the centre, it becomes a $\frac{7}{8}$-inch strap, and continues so to the ends. Each of its ends is perforated with eight holes, three-fourths of an inch apart; and at eleven inches from the tip of each end is a buckle, $\frac{7}{8}$-inch; also a side strap and buckle, *b*, three inches in length on external edge, and two loops higher up one and one half-inch apart from each other and buckle. These are all easily attached to main strap at the same time by means of a leather backing three inches long. When the ends of the main strap are buckled up, as shown, they embrace two small hooks, *c*, to hook on to two brass eyes on the front of waist-belt, C, Fig. 5, four inches from centre of belt.

This magazine brace is made of four pieces joined strongly at the centre with an extra backing of leather. It rests on the kit brace behind the neck, and on the shoulders; and hooks on to waist-belt hooks in front, while *b* and B buckle together at each side of chest after the latter have passed through loops of great coat or magazine bag.

The kit brace, D (shown in Fig. 2), is forty-eight inches long in its greatest length—that is, from tip to tip of strap when in fully extended state. It is a strong bridle-leather curvilinear strap, with a broad centre part twenty-four inches by two deep, cut away behind toward each extremity of this semicircular part for four inches in extent to fit front of shoulders, as seen at *d*. It then becomes cord shaped for four inches, and for the remaining eight (leather) inches, at each end it assumes the dimensions of a one-inch strap. These last eight inches, at each end, loop up and buckle on themselves and inclose in each loop an iron D, to which the hooks of magazine bag, 1 or 2, or coat yoke can be attached as required. Each of these loops is perforated with five holes, one inch apart, for the purpose of lengthening or shortening this kit brace by means of buckles attached. Toward the centre of the broad semicircular part of this brace are two strong iron loops or eyes, *e*, five inches apart. They must be exactly two and a half inches from the centre point of the brace. They pass through the brace from beneath, where they are firmly fixed by means of strong iron stays, which are covered with leather. This brace is made all in one piece, while the magazine brace is, as I have mentioned, composed of four separate pieces of leather, for the sake of economy. When those two braces are worn together, as is usual, the iron loops, *e*, of the kit brace are passed through the holes, *a*, in the magazine brace, and all is then ready for use, and appears as shown in Fig. 3. When on the soldier, they present the appearance shown in Figs. 4 and 5. It

will there be seen that the centre parts of the two braces, firmly connected together, rest on the centre of the lower part of the back of the neck. The kit brace and the main strap of the magazine brace pass together over and in front of the shoulders, where they separate, the latter extending downward to hook on to the front of the waist-belt, the former extending backward between the body and arms, and along the sides well below the axillæ, its rear ends receiving the hooks of the kit bag, magazine bag, or coat yoke, as the case may be. The two back-straps of the magazine brace pass down over back of shoulders and forward along the side of chest, and buckle on to the main strap of the brace at *b*, where the buckles can be easily reached by the hand.

When either of the bags, or the great coat are carried on the shoulders, the back-straps, B, before buckling at *b*, pass through loops on the adjacent face of the bag, or between coat and coat straps, and thus steady them in position, retaining them both by this means and by the hooks which engage the loops or eyes, *e*.

The next things to be noticed are the two bags—the magazine bag, Nos. 1 and 2, Fig. 6 (rear view), and Fig. 7 (front view), which resemble each other in every respect, and can therefore be made on the same machinery. They are simple, strong, canvas waterproof bags, having a thick strong leather backing. They are encircled by two strong bridle leather one-inch straps, *f*, each of which is thirty-five inches long, and are free in front, with one-inch buckle attached to lower end, while their centre part is sewed firmly on to the back of the leather backing of bag at the distance of seven inches from centre to centre of each strap, leaving, however, two interspaces unsewed, to form loops, *g*, obliquely for the back straps of the magazine brace to pass through to steady bag on back.

The leather backing must be made of good sole leather, and measure ten inches full in depth by fourteen inches crosswise at the top, and fifteen inches at the bottom; and the formation of this leather backing, and the sewing on of these straps on back, and also hooks, and a leather loop, *h*, at its centre, for the waist-belt to pass through, is the first step in the construction of each bag; and at the same time the straps are sewed on to this backing three pockets are formed of strong loose canvas in the interior of each of the bags. The centre pocket will require ten inches of canvas, and contain eighty rounds of ammunition: the side pockets will contain each ten rounds.

The front wall of each bag is ten inches deep, and has a length of thirteen inches at the top, and fourteen inches at the bottom. The side pieces that unite the front wall with the backing are three inches at top and four inches at bottom. On the exterior of the front wall of each bag are two loose pockets, *i*, five and a half inches wide, and four inches deep. They are situated near the lower external corner of each bag, and open obliquely upward and outward, and are for the purpose of holding each ten rounds of ammunition. Immediately above each one is a half-inch strap and buckle, which buckles on to a short six-inch strap, extending from the back wall of the bag, to support the pocket when full. The cover or flap of each bag is fifteen by twelve inches.

A central strap, *k*, designed principally to hold the mess tin, is provided for each bag, loops being formed on the bag cover or flap for the strap to pass through. The mouth of the bag is strengthened throughout its entire extent by means of a strong half-inch strap sewed all around, except where the two hooks work at the top of the magazine bag. The hooks are capable of moving from side to side of the bag straps, so as to increase or diminish the distance between them from five to ten inches, and so enable either bag to be carried at the back of neck or buttocks. This is effected by forming the magazine hooks with rings, which are held in loops. Hooks to be $2\frac{1}{2}$ inches and made of $\frac{3}{16}$-inch brass wire, and attached to bag by rivets. Each hook can thus move from side to side of the bag strap as desired. This will be seen by reference to Fig. 6, which is a rear view of the magazine bag with the flap or cover uplifted. The hooks, *k*, are represented in full lines five inches apart, so that they may hook into the eyes, *e*, hereinbefore referred to, and enable either bag to be carried at back of neck. They are shown also, in dotted lines moved farther apart—say ten inches—which is the position they occupy when either magazine bag is carried, not on the shoulders, but on the buttocks by the iron D's of kit brace. In the flap or cover of the magazine bags are formed slits, *l*, through which the bag

straps can pass, so as to be under the covers instead of over them; this being desirable at times when the bag contains ammunition; in which case, by passing the bag straps through the slits and under the cover, the cover may be unfastened and raised, and the bag opened without disturbing the bag straps, which will continue to support and uphold the contents of the bag. In the right wall of each bag are two small outside pockets for the carriage of oil-bottle and a jack knife; and I would recommend that there be a small chamber in the butt of every rifle for the reception of oiled rag.

The next part of my accoutrements is the coat yoke, which consists of two straps and a centre piece, with two hooks attached. It is shown in Fig. 9. The two side straps, *m*, are ¾-inch wide, thirty-two inches long, to encircle and suspend coat, and carry mess tin or a waterproof sheet with great coat; they are connected together near the centre by a strong cross strap, *n*, two inches wide and six inches in length; and at the points of juncture are two small curb chain hooks, *o*, from which the coat can be suspended, either on the shoulders by the eyes, *e*, or on the loins by the iron D's of the kit brace. This device thus affords an easy means of transferring the coat from one point of carriage to the other. The great coat is carried in this yoke so folded that it occupies a space ten inches by thirteen inches, by three inches deep. It weighs four and a half or five pounds. At the centre of cross strap is a small slit for back-straps of "brace" to pass through, and prevent yoke from becoming unhooked.

The magazine brace, with slight change, can be used for cavalry purposes. This is illustrated in Fig. 8 of the drawings.

The cartridge holders I here make use of are waterproof leather pouches, three for cavalry (one reserve) and four for mounted rifles, arranged in pairs, one pair on each side. Each pouch, P, is four and a-half or five inches, with collapsing sides and bottom, capable of containing about ten rounds of ammunition. Each pair is united by means of a strong leather backing ten inches long. The upper free end of this backing tapers to one inch, and holds a one-inch buckle, to which is buckled the front or main strap of the magazine brace. To the backing is also attached a side strap and buckle, *b*, to connect with the back-strap of the brace. On the lower part of the backing is a loop, through which the cavalry sword-belt passes. The sword-belt retains the pouches in their place, while the brace upholds the belt and prevents the sword from dragging at the side.

The pouches lie close against the person, and are not in a position to interfere with the sword or bridle arm. By a simple device, the ammunition is prevented from accidently falling out when the flap or cover of the pouch is unfastened. This device consists of a small piece of leather, sewed on to the front and side walls of each pouch at its mouth, leaving a segmental opening at the back for the extraction of the cartridges by means of the fore-finger and thumb.

This concludes the general description of the bags and braces, and I shall now proceed to state their uses.

When the soldier wears the full set of accoutrements, one magazine bag is carried on the shoulder and the other on the loins, as heretofore specified, each being held at two points, the former by the eyes, *e*, and by the magazine brace straps, which pass through the loops; and the latter by the iron D's of the kit brace, and by the waist-belt, which passes through the belt-loop on back of bag. The bag, No. 2, is for the carriage of the kit, the soldier's bread or biscuit rations, and 20 rounds of ammunition in external pockets.

By this means the havresack is entirely done away with, the meat ration being carried in the mess tin. This bag is in effect the soldier's "clothes box," which, during peace time, is, as a rule, seldom used or needed, but allowed to remain in his barrack room; and on the battle-field the soldier divests himself of it altogether, and leaves it, with the kit it contains, at the base of supplies, either to be piled up, or to be removed in the supply waggons to a place of safety, while its owner is fighting. His number is on it, so that he can easily find it on his return; and if he should be killed in action, Government is saved its loss and that of the man's kit. That part of my accoutrements which takes its place both in peace and war, as well as performs the necessary offices of havresack and extra ammunition pouches, ball bags, &c., is the magazine bag, No. 1—the chief and leading article in my accoutrements.

This special bag, under ordinary circumstances, carries the soldier's great coat and keeps it dry; and when this great coat is taken out of it and carried on its own coat yoke (to be presently described), it leaves this magazine bag free to be used for all the purposes mentioned—either on guard, or on the field of action as a "magazine "bag" in the very fullest sense of the term.

When this magazine bag is to take the place of the other on going into action, or on guard, &c., the great coat, with its yoke attached, is taken out of it, and carried on its own hooks or loops at the back of the shoulders, leaving his magazine bag No. 1 empty and entirely at the soldier's disposal for the carriage of his rations and ammunition on the buttocks. When thus placed the ammunition and rations can be easily got at, not only from the bag *behind*, but in *front*, as it can be unhooked in a moment and run round to the soldier's right front on the waist-belt, where the ammunition can be at once got at by unbuckling only the centre strap, the other two straps remaining still buttoned up for the support of the contents of the bag. The front straps of the magazine brace support the belt and bag then, as well as retains the great coat and mess tin on the soldier's shoulders at the same time, and thus enable him to use the ammunition in the magazine bag while "doubling." The waterproof sheet may best be carried on those occasions beneath the magazine bag on the bag straps. This magazine bag has furthermore, as already stated, strong canvas pockets for the carriage, close to the body, of 100 rounds of ammunition, and it can easily contain and carry 40 or 50 more, in addition to the soldier's day's rations of biscuit, which, with the rounds the man carries in front of his body, amounts to about 200 rounds for siege-operation purposes, a total of 140 only being carried during actual field service, which can be done with great ease and facility; the actual weight carried then by the man being more than two pounds less than the English soldier has to bear when carrying seventy rounds of ammunition in his ordinary heavy marching order.

Fig. 14 represents the soldier fully accoutred. Fig. 15 represents him as he appears with the magazine bag No. 2 removed, the coat yoke taking the place of the magazine bag No. 1 on the shoulders, and the latter transferred from the shoulders to the loins.

The kit brace can be worn, if desired, without the magazine brace. In this case the bag or coat yoke will, of course, be carried on the loins. For most purposes, however, the two braces conjoined will be used.

The next thing to which I direct attention is the mess tin strap. This is shown extended in Fig. 10. The mess tin itself, marked E, Fig. 11, is similar in general appearance and structure to that used by the English soldier, but is somewhat smaller, and contains an inner tin called the "meat can." The cover of this can is used as a plate, and that of the outer tin as a frying-pan.

The strap which binds up the mess tin is composed of crossed straps, *p* and *r*. The broad strap, *p*, is twenty-two inches long, two inches wide at the centre, and one-half inch at the ends. The other strap, *r*, is a half-inch strap, twenty inches in length. There are on the broad strap three loops, *s*, for the mess tin straps of the bags to pass through. When the strap is on the canteen its broad part rests perpendicularly on the back of the tin, and its buckle end crosses the lid and reaches to brass loop in front. The mess tin by this means can be carried in no less than six different places on the accoutrements.

The water bottle is that now in general use (see Fig. 12) in the service, but modified by me in a very simple manner, so as to obviate certain serious objections it previously possessed. By attaching to it a brass "rest," and leather "protector," it can be now carried out of the soldier's way in a fixed position behind the right hip, whence it can be removed or replaced with facility; the necessity for, and expense of a chest strap is also done away with; and its metal rims are effectually prevented from staining the scarlet clothing, or falling off when the bottle is dry in store or barrack room.

The magazine pouch, G (shown in Fig. 13), is similar in shape and construction to the cavalry pouches above described, being, however, considerably larger. It is carried on the waist-belt in front by means of a strong four-inch back-strap, loop, and button. This strap, *y* (indicated by dotted lines in Fig. 13), is firmly sewed to the top edge of the pouch behind, and has in its lower end a button-hole slit, to button

on to a stud at the bottom of the rear face of the pouch. This strap is passed between the soldier's belt and body in front, and is then buttoned down, the pouch then occupying the position shown in Fig. 5.

The bags and great coat can be carried by means of iron or brass loops and buttons, instead of by hooks and loops, as herein described, should such be considered more desirable.

How to wear and use Accoutrements.

The accoutrements can be used and worn in different ways, the weights to be carried (which may be either kit, ammunition, great coat, blanket, waterproof sheet, medical appliances for use in the field by Army Hospital Corps, or trenching tools for throwing up earth works), being all transferable from one point of carriage (shoulders and buttocks) to the other with great facility.

When kit, great coat, and waterproof sheet, and 70 or 80 rounds are carried as represented in Fig. 14, the kit with sheet is usually carried below; and when such is required the waist-belt is passed through the waist-belt loop of whichever bag contains the kit, and the hooks of the bag are separated to their full extent, while the hooks of the other bag (which is to contain the great coat) are to be placed on the inner side of bag straps, and attached to iron rings of the conjoined braces, and the back-straps of "magazine brace" are then passed through the loops on back of bag.

The waist-belt is next taken, the right end in right hand, and left in left, and buckled (with bag attached) around the waist; and in the same manner the conjoined braces are taken—right in right, and left in left—and the bag and coat thus lifted on to the back of shoulders; the front straps of "magazine brace" are then followed down by the hands, and its ends hooked on to the loops in waist-belt; and the D's in kit brace attached to loops of kit bag; the back straps of "magazine "brace" are next buckled at side of chest, and all are on.

The waist-belt should be open while this is being done. By catching coat sleeves in each hand and extending both arms, and also drawing on conjoined braces in front of shoulders, every part will assume its proper position, and rest extremely easy on the body. The "magazine pouch" is next attached to front of waist-belt; and water bottle either slipped around on belt, or hooked on to it behind right hip, and the soldier is fully equipped in "heavy marching order."

The soldier can now get at waterproof sheet or any portion of his kit in a moment, by merely unhooking left hook of lower bag from kit brace and moving it round on waist-belt to right front; he can also take great coat from back, and replace it himself *unassisted* or *without removing accoutrements*, by simply unhooking both braces, and lifting bag off shoulders, and the same can be replaced as already described.

As the soldier is now accoutred he is carrying the two bags—in one of which he has his great coat, and in the other his kit and bread ration. If the latter should exceed a pound in weight, and he should require more, he can easily make room for it by removing the shirt and towel from the kit bag and transferring them to that containing the great coat.

He seldom, however, needs to carry and use the two bags in this manner, as the weight and carriage of the kit is a most useless and unnecessary encumbrance to the soldier on almost all occasions, except when required to march with it from one station to another in time of peace, or carry it to the "base of operations" or the outskirts of an engagement in time of war.

When so accoutred, however, he is prepared for any emergency, and in possession of the same amount of food, clothing, and ammunition as the soldier is when equipped in "Heavy Service Marching Order" in the "Valise Equipment," the ammunition being disposed of as follows: 30 rounds in "expense pouch" in front, 20 rounds in breast pocket of tunic or jacket, and 10 rounds in each of the outside pockets of lower "magazine bag."

But for ordinary daily duties, guards, parades, field days, or active service in the field of battle, the soldier only needs one bag, the other being almost under all circumstances left in the barrack room in peace, or at "base of supplies" in war as a "reserve bag."

On those occasions the great coat is taken out of "magazine bag," No. 1, and suspended on its own "coat yoke," either at the back of shoulders or buttocks—

always the former when the "magazine bag" is required for use. See Figs. 15, 16, 17.

This leaves the "magazine bag" free for the carriage of bread rations, waterproof sheet (at bottom of bag), and from 100 to 140 rounds of ammunition.

The "mess tin" is, under those circumstances, carried either on top or bottom of great coat on "coat yoke," provision being made in mess tin straps for the latter contingency.

The "water bottle" is slung on waist-belt, as before mentioned, behind right hip, and the "magazine pouch" in front of waist-belt; and the soldier is then carrying from 140 to 200 rounds of ammunition, a waterproof sheet, great coat, and a day's rations of food and water. Not more than 140 rounds should be thus carried except when required at siege operations.

When this large amount of rations and ammunition are thus substituted for the weight of the kit they are distributed as follows:—Bread rations in "magazine "bag" behind buttocks, meat ration in "meat can" of mess tin over or under great coat, 80 rounds in the centre inside pocket of "bag," and 10 in each side pocket; 10 in each outside pocket of "bag" 20 or 30 rounds in "expense pouch" in front, and 10 in each breast pocket of tunic or jacket. These latter should be composed of strong waterproof material and have their openings sewn up during peace and open in war.

When the soldier has expended all the 60 or 70 rounds he can carry *outside* of "bag," in bag pockets, tunic pockets, and "expense pouch," as specified, and requires more, he has merely to unhook the *left* D, and bring the "bag" round on waist-belt to his right front; when he can either replenish pockets and pouch, or expend ammunition direct from the "bag" itself. (See Fig. A.)

The great coat should have no cape or shoulder straps, and should weigh from 4½ to 5 lbs., and be folded 13 in. wide, 10 high, and 3 in. deep.

When it is carried on its own yoke (Fig. 15) on the shoulders, the back straps of the "magazine brace" are passed between coat and its straps in front, when coat yoke hooks have been hooked on to iron rings of conjoined braces.

The "mess tin" can be carried in six different places, either above or behind "magazine bag," Nos. 1 and 2, or above or below great coat, on coat straps.

The soldier can march with his waist-belt open. The magazine pouch is then transferred to the left side from centre of waist-belt. (See

All accoutrements, kit, coat, &c., can be removed at once by unhooking *right* D of kit brace, and right chest strap, and opening waist-belt, and removing like an ordinary waistcoat.

The "magazine pouch" can be carried in the centre pocket of bags when not required for immediate use on waist-belt.

When blanket, splints, trenching tools, &c., are required to be carried by accoutrements, the straps on "magazine bags" can be utilized for that purpose. The coat, boots, clothing, &c., when wet, can also be carried by the same means *outside* of bag.

SOLDIERS' FIELD KIT.—*What it is to contain, and how disposed of.*

Consists of one pair of boots, one pair of summer trousers, one cotton shirt, one pair of socks, one towel, one holdall, complete, containing needle and thread, bootlaces (spare set), knife, fork, spoon, razor, and shaving brush; one piece of soap, one hard brush, and a clasp knife.

Place legs of trousers together, and fold them in the usual way to one-third of their length, which will make their dimensions about 10 inches by 16. Then pack them in bag, front edge upwards, and the flat against proper back of bag. Next roll holdall up carefully (it should contain spare boot laces, needles, and thread) and place it with one sock in one boot, and the hard brush and piece of soap and other sock in the other boot. Then place both boots together (with ankle leather folded down), heel to toe and upper to upper, at the bottom of bag, behind trousers, with the sole of one boot on the bottom of bag, and that of the other looking upwards. Next draw the boots well asunder, to fill all space at bottom of bag. The edge of the trousers, which now appears above the upper boot, should be folded down on a level with it. The shirt is next rolled up hard inside of towel, 15 or 16 inches lengthwise, and packed against proper back of bag, over the trousers. The blacking

tin and small book are placed at opposite ends of bag—between bag walls and contents. The forage cap, when not worn, is carried in the other bag with the great coat under coat yoke straps, and clasp knife in pocket for same near oil bottle in bag.

The meat, as before-mentioned, is carried in "meat can" of mess tin, and the bread and biscuit ration in the loose pocket which either bag has for that purpose.

Should there not be ample room for the bread ration in the lower bag, when the full field kit is being carried there, the shirt and towel are removed from there and carried folded flat in the upper bag with the great coat, as already mentioned.

When coat alone or rations alone need to be carried, the bag or the coat is carried below behind buttocks on kit brace and waist-belt.

My system of equipment is intended to render every soldier independent and self-supporting, and be in every respect his own magazine; and, when circumstances admit of it in the field, and heavy fighting is anticipated; or when during siege operations the soldier needs as much ammunition and food as possible in the trenches, to render him self-supplying, and save both the precarious necessity for hand-carts in the field, or to have men employed and exposed to the enemy's fire while bringing up supplies to advanced posts from the "base of supply," I propose that the soldier should disencumber himself of unnecessary articles of unnecessary weight, and be his own "magazine," by divesting himself of such portion of his kit as he does not require for the time being, and substitute—

	lbs.	oz.
A waterproof sheet weighing	2	6
And 140 rounds of ammunition	16	10
Total weight	19	0

For the present weight of—	lbs.	oz.
Coat cape	1	11
Field kit	10	12
2 ball bags and havresack	1	11
And 70 rounds of ammunition	8	5
Carried by the British soldier in action	22	7
Proposed weight of articles of clothing, food, and ammunition, which will render him independent of his base of supplies for 24 hours, shows a balance of weight in soldier's favour of 3 lbs. 7 oz.	19	0
Less weight	3	7

I, of course, intend that the waterproof sheet[1] should be used and carried on all occasions instead of the coat cape. It is so much more useful; protecting the man from rain or dew at night, either as a cape or sheet, or (two joined) as a *tente d'abri*; or he can rest on it on damp ground on the halt, or at night; or he can carry and use it instead of the great coat itself in time of peace, to protect him during *wet* but warm *weather* on field days, guard, or while performing any of the duties of a soldier. As an extemporary stretcher or splint-cloth it will also be found most useful for its wounded possessor in time of war.

The Trenching Tool.

Advantages:—

1st. Can be used with greater efficiency than shovel, trowel, or pick on almost all occasions in the field, and especially grass ground.

[1] This sheet is composed of strong waterproof material; weighs 2 lbs. 6 oz.; is 6 feet by 3 feet 9 inches, and has an oval space 3 inches deep at centre of one of its long margins to fit neck when worn as cape.

It can be carried *rolled*, 17 inches by 3 inches under bag straps at top or bottom of bag; or at back of bag *folded*, 15 inches by 10 inches; or in the coat yoke instead of great coat, when the nature of the *weather* or *duty* render such advisable.

2nd. Acts the part of a measure, shield, spade, and shovel, and will enable the present number of men (125) using picks to be reduced to 40 per 1,000, and spade men replace them on service.

3rd. It weighs 2 lbs. 6 oz. less than the united weights of the present *light pattern* pick and shovel.

4th. Can be carried by every soldier with or without bayonet in ordinary frog, either by the "Oliver" or valise equipment, without alteration in their construction,[1] and be detached for use with great rapidity and facility.

Method proposed for the Carriage and Use of the Trenching Spade.

I beg to make the few following remarks regarding the above, not only as to its use and carriage, but respecting the system by which I propose to accomplish both those objects most efficiently; and which is altogether based on the same principle as that of my accoutrements, viz., that of rendering every soldier his own "magazine," self-supporting, and independent of his "base of supply," and as light and free from all unnecessary weight and impedimenta in the field, &c., as it is possible to accomplish. Acting on this principle, I beg to suggest, that the *soldier himself should be the bearer of his own trenching tools*, instead of using the present cart for that purpose.

Trenching tool carts, or pack horses, like ammunition carts, under the enemy's fire, are dangerously precarious in the extreme, as means of supplying men in action with either ammunition or trenching instruments—so liable are the animals drawing them to be killed or wounded, or the carts themselves rendered unserviceable by shot or shell at the critical moment, perhaps, when they are most needed. And, irrespective of this, their transit over roadless, hilly, swampy, or wooded ground, within supply distance of the regiment to which they are attached, may be found almost impracticable, if not quite impossible, and be fraught with the most serious consequences—no tools being within reach when the moment of necessity urgently demands their immediate use.

If every soldier does not carry a trenching tool (which for many reasons would not be advisable) certainly 280 men per 1,000, or per regiment, ought to be within easy access of them; and the tool or tools placed at the men's disposal should undoubtedly be the very best that art can devise for the special service on which they are to be employed.

Two of the different advantages that I claim for my spade are, that it can act the part of spade and shovel, and also considerably reduce the present number (125) of men using the pick. On trial (for light field works) I trust it will be found practicable and advisable to reduce this number to 40 per 1,000, and to place my spade in the hands always of 240 men per 1,000, and often to extend its use to the entire 280—when the use of the pick is not required.

How I propose to accomplish this is as follows:—Instead of having a two-horse cart for the carriage of the tools for each regiment, let there be two two-horsed covered carts, one for each wing, to be called "kit carts," and be for the carriage, on my system, of the kit bags and kits of 280 men. This would relieve each of those men of 12 lbs. 12 oz. of useless impedimenta; and place each of them in the field unimpeded while carrying, 40 of them,[2] 40 picks and handles, and 240 of them —240 spades complete. The weight of each pick or spade complete would be 3 lbs. 6 oz., or 9 lbs. 6 oz. less than the weight of kit and bag; so that each of the 40 pick men could also carry a light hand axe weighing 2 lbs. 5 oz., and 70 rounds; and the remaining 240 a corresponding weight of extra ammunition—90 rounds—and still be 7 lbs. 1 oz. lighter in the field than the English soldier is in "service "marching order," and carrying, like the pick men, 70 rounds of ammunition. Those

[1] The frog alone requires a slight addition to be made to it; and in the case of the "valise equipment" the two small bag straps may have to be shifted from outside to inside the bag flap to retain spade cover.

[2] The present light pattern picks and handles could be used for this purpose, or these pick heads could be made to fit my spade handles.

280 men would also be in possession of their rifles, bayonets (not sword bayonets), water, food, great-coats, waterproof sheets, and clasp knives; while they each carried those 5 lbs. 11 oz. of useful trenching tools, instead of 12 lbs. 12 oz. of useless kit and bag.

It must be remembered, also, that the 20 extra rounds per man of ammunition to the 240 men will place 4,800 extra rounds within easy reach of themselves and comrades.

The cubic space required in each cart for the kits and bags of 140 men would be 60 cubic feet; and the weight to be carried by each 16 cwt. Those carts would be kept out of reach of the enemy's fire in the "first line" of transport, and be within sufficiently convenient distance of the men themselves.

The tools and ammunition are easily disposed of for carriage as follows:—The spade handle is carried with bayonet in the ordinary frog, and the spade head in front of chest in "cover" as "shield" (see Figs. C, B, D); or by the "magazine "bag" behind buttocks, either inside bag or under bag flap on the bag straps, the spade and cover being retained in this latter position by the straps of bag being made to pass through the buckles on the face of the spade cover. Pick handle in frog of waist-belt; pick head inside, or at bottom of bag on bag straps. To equalize the weight of ammunition and spade head:—when the latter is carried in front, only 20 rounds of ammunition should be carried in the "expense pouch"; and when the spade head is carried behind, 30 additional rounds might be removed from the "magazine bag," and carried, 10 in each breast pocket of tunic or jacket, and 10 in "expense pouch" on front of waist-belt. His own common sense will, I trust, guide each man how to act most judiciously in this respect.

With but a slight modification in its construction, the ordinary frog can carry both the spade or pick handle, and bayonet; and the combined weight of handle, bayonet, and sheath is *less* by 7 oz. than the present rifle *sword-bayonet* and *scabbard*. These latter are also 1½ inches *longer* than my spade handle; and, therefore, in rifle regiments, the 280 men per 1,000 employed as "trench men" should be armed with bayonets instead of swords.

When the moment for action occurs in the field, those 280 men can be in readiness for work with their tools,[1] *by this system, in less than one minute;* and if they should be suddenly surprised at their work by the enemy, or want to retire or advance at a moment's notice, they can, almost instantly, place themselves in a state of defence, and in possession of their rifles, by reversing the handles in spades, and carrying them, thus slung, on front of waist-belts.—See Fig. D.

I would also beg to recommend that the 280 "trench men" per 1,000, should receive special instruction in the construction of field works, &c.

In conclusion, I beg I may be excused mentioning and suggesting, that, if my propositions regarding the "trenching tool carts" were also extended to the "regimental reserve ammunition carts," 420 more men per regiment could be relieved of their kits and kit bags; and, in lieu thereof, could each carry an additional 70 rounds of ammunition; which would make a total of 29,400 rounds extra, and would amount to no less than 600 more rounds than the whole three ammunition carts carry at present—while the actual weight of the extra 70 rounds of ammunition per man would only be 8 lbs. 5 oz., as compared with the 12 lbs. 12 oz. of kit and bag from which each would be thus relieved.

When war is localized, and there are standing camps, and a fixed "base of opera-"tions," whole regiments can almost constantly dispense with the necessity of carrying their kits and "kit" or "reserve bags," and carry in their *second* magazine or "service bag" to the "front," an amount of food, ammunition, and necessary clothing sufficient to render them independent of their "base of supply" for twenty-four or forty-eight hours.

W. S. OLIVER, M.D., F.R.C.S.I., *Surgeon-Major.*

---

[1] My bag, being transferable in a moment from *back* to *front* of waist, enables the spade head to be carried in or on it behind buttocks within easy and immediate reach for use. This the Government accoutrements do not admit of; and consequently the spade head is best carried by them in front of chest.

Rear-Admiral J. H. Selwyn: This being principally a military matter I should have preferred to have waited for my brethren of the other arm, but, as my name has been mentioned with regard to the attachment of the spade to the rifle, I will advert to that and to one or two other points. I will only say that in the Navy our opinion of the accoutrements of the military branch has been for many years so bad, that we consider the best thing a Marine can do, at the double, is to take his rifle under his arm, put one hand to his cartridge box, and the other to his shako, in order that he may lose neither of them. I have very long had a high opinion of the Rice trowel-bayonet as a means of rapidly entrenching troops. No doubt the recent occurrences in Turkey have shown us the extreme value of even hastily thrown up entrenchments under modern attack, and more attention must necessarily be conceded to the subject. But, I object first to that fact, that although the moral effect of a thing which will nearly cut you in two may be very considerable, yet, the value of a point and the length of that point was very clearly shown by the lecturer, when he spoke of the different lengths of the old Enfield arm and its bayonet, and the modern Martini-Henry without its sword-bayonet. No doubt the original idea was that the sword-bayonet added to the length of the Martini would be equal to that of the old weapon, but, as we have had to give up the sword-bayonet, we have lost the length which was of value. Incidentally we lost also the weight of the arm which prevented the kick sure to be given by a large charge. The bayonet (as well as the lance) has been called the "Queen of Weapons," and Marshal Suvaroff said that the bullet was a fool and the bayonet a hero; I, therefore, do not like to see it done away with, and I think it is still useful. At the last attack at Chipka, there was a ten minutes' combat between the rival infantry with the bayonet. It seems to me that the trowel-bayonet could be very well carried on the outside of the stock of the rifle without increasing the weight. A certain portion of useless wood would be taken away, and the soldier would then have an entrenching tool and also his bayonet without increased weight or complication.

With regard to the question of the calibre of the revolver, some time ago I went to the War Office to bring to their notice the Smith and Wesson revolver, which I had seen largely used in America, and which is a very efficient weapon. I was told, first, that a double-barrelled breech-loading pistol had been sealed for use; and, secondly, that the instructions issued prevented any cavalry soldier using his fire-arms for any other purpose than signalling. That was a sufficient answer for me and I left the subject. Now, I am happy to hear that a revolver has been sealed for certain modified use in the cavalry, but the great error the lecturer pointed out is, that with the one weapon your bridle-hand is not used at all, with the other weapon you must take two hands and pick out every cartridge after you have discharged it. With the American revolver you throw out the cartridges by a simple movement which leaves the chambers exposed and which does not throw out any cartridge you may not have discharged; with the other you have to take out a ramrod, turn it round, and then force out each cartridge. You may imagine what sort of an operation that would be in a *mêlée*. The calibre of the bullet has been increased. This is an unmitigated benefit in one respect, that it does give a bullet capable of stopping a man at once, but it has its disadvantages; you must either give a larger charge to the same bullet, by reason of its increase of weight, if you keep the same proportion between the length and diameter, or you must have a bullet which is too short to give the best results. If the bullet be increased in weight, and you want more than the 23-grain charge, which is sufficient in the Smith and Wesson revolver, I hear the present charge is only intended to be 15 grains, or you must shorten the bullet, and then you get less accuracy. Between these two dilemmas, I should prefer a moderate charge of powder, a lessened range, and greater stopping power, but it is essential to have a weapon which does not require the use of the bridle-hand if you are to have a weapon efficient for cavalry. I have had considerable experience in the West of America, where they are very fond of using the revolver, and where these matters are attended to very closely. The pull-off trigger is a great improvement over the American pistol, and it is that which has induced the Americans in California to call the English pistol the English bull-dog. With regard to the proportion of the powder to the bullet, and the weight of the case, you will find that in the simple metallic cases, without any mixture of two metals,

the Americans have avoided some very difficult points which still exist with our own ammunition, and, as you improve breech-loading arms, you not only use more ammunition, but you are obliged to have more of it in stock. Anything that bears on this point is of very great importance. Our present cartridge is made up of iron, lead, powder, brass, and paper; the American cartridge has nothing in it but brass. The English cartridge has a bell, cup, an anvil, a detachable iron disc, and a fulminating cap. An American cartridge has nothing but the one fulminating cap. This is simplicity, and that is its value. Now let us look at the weight. The Daw cartridge (which received a prize in this country before the American cartridge was generally known) weighs ten per cent. less than the English cartridge as it stands at present, that is to say, you get on the 100 rounds 10 rounds more with the same weight. The English cartridge again, when kept in store, by the galvanic action between the iron and saltpetre destroys its own case. The American cartridge does nothing of the kind. It is worth while to look at all these things before we find them out in actual practice. I should have said I quite recognize the advantages held out by Colonel Rice, in giving the soldier an efficient tool for all purposes, such as cutting brushwood and other things, which we cannot do with the bayonet attached to the stock; but still, I think, if you put a thing to too many uses, you are very likely to have some of them inefficiently performed. In the latest development of an American magazine rifle, which has been exhibited here for the first time, it has not yet been shown in England at all, you have remarkable simplicity, great power of firing without taking the weapon down from the shoulder, and the perfect balance of the weapon, which we have sought in vain in other rifles. It is quite true when loaded as a magazine arm it weighs more, but when you want to use the magazine such considerations disappear altogether. When you use the weapon for accurate firing at long ranges, you do not use the magazine and the weapon retains its normal weight; but when you want to shoot half-a-dozen cavalry soldiers one after the other, without taking the arm from the shoulder, you do not care whether the weapon is a little lighter or not, provided you can accomplish that object. I can only congratulate the author on the comprehensive way in which he has treated those few subjects amongst all he has referred to with which I am acquainted; I can only hope other Officers connected with other subjects will have reason to say as much as I have great pleasure in doing. I must congratulate the Institution on a most valuable paper.

Captain the Hon. H. G. CRICHTON, 21st Hussars: I can show best by unpacking the kit how simple the arrangement of it is. I have found it necessary to make certain alterations since I first commenced which do not alter the principle but only the details of the equipment; these alterations I had arrived at by watching the trials which took place last summer. The numnah now could be made of felt or leather, and there were no stitches or rivets next to the horse's skin, which were necessary in the way I at first constructed the numnah. The front and hind parts of the numnah are made self-supporting by thin pieces of sheet steel, which make the saddle independent of the numnah and the kit attached to it. The saddle has been made longer so as to give the man more room in it, and the side-boards are closer together, so as to keep it more off the back since it is ridden without panels, and can also be ridden without numnah in light order.

I look upon the blanket as infinitely preferable to the panels. As to begin with, the former is useful for covering the horse when standing out in cold weather, and every time it is refolded it is like re-stuffing the panels, which always will in time, and with no opportunities of re-stuffing, get as hard as a board; the danger of the blanket when it used to be worn under the saddle was, that if carelessly folded it became wrinkled, or gravel perhaps remained on it when folded on the ground; and, above all, it was sure to slip back from under the saddle, the grain of the horse's hair causing this. In my equipment, the two former dangers are very much lessened, as there is a layer of felt and leather under the blanket, and the third is altogether obviated as the blanket does not touch the horse's skin in any place, but lies on top of the numnah between the front and hind part.

The sheep-skin which covers the regulation saddle of course adds very much to its appearance, but occasionally it covers a multitude of sins in the way of a badly packed kit beneath it. I could equally well cover mine with a sheep-skin, but I

think a waterproof sheet for the man to lie down on in camp or bivouac, with two pockets for his kit, and made like this one to roll up into a pocket at the end, is infinitely more useful, this being made of strong waterproofed canvas keeps the kit in it dry, and is packed on the hind part of the numnah, the front part is kept dry by a waterproof horse-cover like those at present used in camp. These two very necessary waterproofs are thus always with the horse instead of being carried in the waggons, where they are so likely t remain if cavalry are pushed to the front, and their combined weight is about the same as that of a sheep-skin.

I have made my new numnah the same shape in front as behind, so that it can be reversed and the pressure on it will be in different places according to which way it is turned, and it is not so liable in this way to get hard in one particular spot where the greatest pressure is.

The water-bucket, which is fastened to the shoe-case and shaped like a sabretache, is intended for use in places where the banks of canal or river are too steep or too boggy to allow the horses to walk into water; also it frequently happens in camp that the carts with buckets, &c., are late in arriving, and the men at a standstill for want of something to draw water in to clean their equipments; under these circumstances I consider a bucket of this description very essential.

The lecturer remarked that the question of leather or felt next to the horse was a moot point, it certainly is a very important point, and one that requires a great deal of consideration in settling. The felt I think requires a great deal of care, and is often rubbed, scrubbed, and beaten into holes before very long, if not backed by something strong, it also requires sun or fire to dry it; the leather merely requires to be sponged over and kept pliable with oil, fat, or soap, and does not require sun or fire, but the leather ought to be backed by something soft. I also think that the felt when too great pressure comes on it rubs up and stretches the horse's skin, which wrinkles it, and matter forms under it, which causes a much worse description of sore back than leather, which rubs the hair off without stretching the skin: under these circumstances I am inclined towards the leather in preference to the felt.

Captain APPLIN, late commanding H.M.S. Legation Guard, Japan, and late Military Train: With your permission I should like to make one or two remarks. With regard to the pistol, I think that Admiral Selwyn is perfectly correct. My opinion is that the quantity of powder used is a great mistake; it is considerably too strong a charge. Using a pistol, no man should fire certainly at a greater distance than twenty paces on any consideration. Some six or seven years ago in Japan it was necessary for every man to carry a pistol, but the Japanese invariably got the better of every man carrying one, even when he had it in his hand. The fact is, the Colt revolver is the very worst weapon you can possibly have, for after being loaded a week, probably not more than one of the whole five barrels is useful. I have seen sixty men armed with these revolvers, of which not more than three-fourths were of any use. I very nearly lost my own life through the inefficiency of this weapon. For the breech-loading pistol the charge is also considerably too strong. You do not want *penetration;* what you really require is a breech-loading pistol which can be easily loaded and unloaded, and will carry a bullet heavy enough to stop a man. Then with regard to the sword and lance, there is no doubt the lance is an effective weapon, but it is very easily put on one side. I think in a charge against infantry it is effective, but I do not think it is so against cavalry. A man of nerve, a well-trained soldier, might very easily put the lance on one side. I maintain the great fault in our swords is that they will not cut. Use them as much as you like, unless you have them specially sharpened the night before, they are useless; and then we do not use the point of our swords as we should. The most effective part of the weapon in the hands of a good cavalry soldier is the *point*, and you will see this at once, because you have to raise your arm into all sorts of positions for the cut. In the cut our swords are useless in nine cases out of ten, as was shown in the Crimean War. Then with regard to saddles there can be no question of the vast improvement made by Captain Crichton. There is no doubt that the Indian numnah is far preferable to anything that has ever been invented yet. I have taken my troop sixty miles in ten hours without a sore back, or the loss of a shoe, over rough country. Some of my men rode 22 stone, and the horses were only

14 hands 2 inches in height—little Arabs. I did not do this only once, but I was constantly doing it for seven years with the same horses. When I left, they were from twenty to twenty-two years of age, and I never had a sore back during my command, always using the Indian numnah. I think that is good proof of their utility. I cannot refrain from repeating that something should be done with regard to the sword exercise in our cavalry, so as to do away almost entirely with the cut. You might have the weapon two or three inches longer; and I am sure any practical man who has gone through one or two campaigns will see the advantage of using the point rather than cutting. The Japanese use two-handled swords; if we could use them, I should say *cut* by all means, for they never want a second cut. With regard to the small bullet and great penetration, I remember that in one case after a man had been shot through the chest with two bullets from a *Colt's* revolver, he succeeded in killing two men, giving one man sixteen wounds, every one of which was death. This I saw with my own eyes, and I brought in the man myself. There is no weapon equal to the breech-loading revolver in the hands of men who know how to use it; and as to the sword I certainly prefer it to the lance.

Lieutenant WALTER H. JAMES, R.E.: There is one point I have not heard touched upon, viz., the question of a forage cap. In the British Service we have, roughly speaking, two patterns, that worn by the Guards, the cavalry, the Engineers, and the Artillery, and the "line" forage cap. To my mind, neither of these fulfils the requirements of a proper forage cap, and neither of them on service would be of any use at all. The infantry forage cap is too small: it does not cover the head, it may have what we call a soldier-like appearance, but it would be quite useless on service to protect the head from the weather. The same objection holds good with regard to the other pattern, it goes to pieces in a very short time, and does not cover the head. But we have in the well-known forage cap that the Guards used in the Crimea the elements of a good cap, and I must say it is one I should like to see introduced throughout the service. On the question of the bayonet, Admiral Selwyn has, to my mind, hit the nail on the head, when he said that the "Rice "bayonet" would not fulfil every purpose. If it be used as a digging weapon, it will certainly fail as a cutting weapon and as a weapon of attack. With regard to the length of the Martini-Henry, the question of the use of the bayonet has, to my mind, been somewhat exaggerated. We are told that only one per cent. of the casualties in the late war were caused by the bayonet, and that is the very reason, to my mind, why we should not have a weapon as we had in the old Enfield, which was cumbersome by its length, simply for the purpose of having the bayonet at the end of it. When the Martini-Henry rifle was first introduced I shot with it myself, and saw a great deal of shooting with it. I confess I utterly failed to discover that it kicked to any great extent. Certainly the recoil was not more than that of the Snider-Enfield, and I believe that the opinions of a great many first-rate shots in the regiments to whom it was issued coincided with mine.

NOTE.—The lecturer objects to the Martini-Henry, firstly, on account of the spiral spring, and, secondly, on account of the divided stock, which he states increases the recoil and renders the breech difficult to shut in a variable climate.

With regard to the first objection, I may observe that France, Germany, Russia, Italy, and Switzerland use spiral springs, and that the campaigns of 1848 (Baden Insurrection) 1864, 1866, and 1870—71, have proved most conclusively that locks constructed on this principle are quite capable of withstanding the trials of war. So far from being unmechanical, the testimony of such eminent mechanicians as Professor Pole, Mr. Nasmyth, and Mr. Woods was distinctly in favour of the spiral as opposed to the flat spring for the purpose required of it, while the wide-spread use of Salter's spring-balances shows that, so far from being uncertain, spiral springs are most accurate and reliable in their working.

With reference to the second class of objections, it is a mechanical impossibility that the old stock could absorb any of the recoil by its elasticity. The recoil is transmitted directly to the shoulder, which, being elastic, yields to it. In order to absorb a portion of the recoil in the stock, it would be necessary to construct it of a material more elastic than human flesh and muscle. Such a material, I need hardly point out, would scarcely possess the other requirements of a military rifle stock. As to the contraction and expansion of the stock, if it be constructed of well-

seasoned wood it ought not to be so much affected by atmospheric changes as to render the lever difficult to close. At any rate, this objection would apply equally to an undivided stock, and is at the worst easily capable of remedy.

The Martini-Henry rifle has, in the present war, given proof of its capabilities, and shown practically, what those who have theoretically investigated the matter knew before, that it is a first-rate infantry weapon, and that armed with it our troops possess a rifle, which, in regard to ballistic qualities, flatness of trajectory, range, accuracy, and penetration, is superior to any in Europe.—12/2/78.—W. H. J.

Surgeon-Major OLIVER made some remarks on entrenching tools and how to carry them; but as a full account is given of these particulars in the appendix to the lecture, his remarks are not given here.

Lieut. GRAVES: I have to thank you for your kind attention to my lecture. With regard to the trowel-bayonet, I quite admit it is too short to be an effectual weapon when compared with the sword-bayonet, but if the moral effect is maintained, I think we may leave the actual effect to take care of itself. It is meant to be used in the hand simply, in a kneeling position, and not attached to the rifle when digging. Then, again, with the implement at present in use, the men will take fifty minutes to get the same cover as the trowel-bayonet will give them in six minutes; therefore, I maintain, we should have a tool to be carried by the man which will give cover in the shortest time.

With regard to the charge of the revolver, I believe myself that ten grains of powder would send a bullet that would stop a man with quite sufficient final velocity, and do quite as much as the stronger charge of powder with a smaller bullet. It is not a projectile for piercing that we want, but rather something that will stop the man. We have just heard from Captain Applin about the Japanese man who, after receiving two bullets in his body, did such execution amongst his enemies. The fact was, the bullet was too small to stop him. It most probably went right through him. What we want is something which will actually stop the man and incapacitate him from work. With regard to the length of the Martini-Henry rifle, I cannot quite agree with the observations which another Officer has made, because by giving up the length we have actually lost the flat trajectory that is so much needed. We do not have the same final velocity that we had when the longer barrel was used, and that is what we want. We want the greatest possible final velocity at the greatest possible distance. The short rifle does not give us that velocity, to say nothing of the disadvantages connected with it when the man is standing at the order. With regard to the numnah, three years ago I proposed that the saddle should be made without panels, so that it should require no stuffing, but should be made simply with about three inches thickness of numnah covered with leather. This would fit to the horse's back at any time, supposing the panels were not made with the unyielding substance of which they are now made, and it is now a moot point which is the best plan. With regard to the Oliver equipment, there is one thing I ought to have drawn special attention to; it is this: that with it the man can always have his hand upon his ammunition. We have a very small army, and the chances are that we shall never be engaged with a Continental power, except on the defensive, and we want to have the man's hand so continually on his ammunition that he may be able to fire with the greatest possible rapidity. We want something to enable a man to carry about 170 rounds of ammunition, and to use it as quickly as he choses. The Oliver equipment for an infantry regiment of 1,000 bayonets carries 72,000 rounds of ammunition more than the present system. Captain Applin has said that there was very little effect from the revolver in the Japanese war. What was the reason? In the first place the bullet was too small, and in the next place the revolver had not a pull-off action. The weapon His Royal Highness has chosen for the Army is one of large calibre, and with the pull-off action, so that a man can shoot as quickly as he can pull his finger. If a lot of men get into a *mêlée*, armed with this revolver, by the time that the men have got to the end of their magazine the fight ought to be pretty well over.

A question was asked by another Officer about our forage caps. His Royal Highness the Duke of Connaught at the same time that I proposed my jacket, which is now on trial, brought forward this cap (Fig. 20) for the Hussar regiments on service.

There is a similar cap, having a different ornament, for the lancer, and another for the heavy dragoon. I think it gives everything that is wanted, and this is the sealed pattern which has been placed at my disposal by the Assistant Adjutant-General. I have to thank you for the kind attention which you have given to me.[1]

The CHAIRMAN: There are one or two points I noted during the course of the lecture, which I perhaps might draw attention to. I think the lecturer made same slight mistakes in his figures. First with reference to the proportion of guns. He stated that in some armies at the present moment the proportion of guns was 8 to every 1,000 men. I think he is wrong there; because, if I am correctly informed, I think the proportion of guns laid down, according to regulations for our Army, comes up to quite the same proportion as that established in the German Army, namely, 3½ or 3¾ for every 1,000 men. The next point is about revolvers. A good deal has been said upon that subject, and I fully concur in the remarks which have been made. I certainly agree with reference to the advisability of giving the revolver to artillerymen. At the present moment an artilleryman is really in the most defenceless condition: for if his battery is charged, unless he uses his handspike, he has actually nothing to defend himself with. Every gunner should be furnished with a good revolver. As to the size of the revolver, what we want is one carrying a heavy bullet. We do not want a weapon that will kill a man at 100 yards. One gentleman said 20 yards, but nothing would ever induce me to use a revolver at a greater distance than 10 yards. If the pistol is only required for use at very short distances, I think you can very easily reduce the length of your revolver-barrel, which is at present usually too long; by doing so you would make it more handy for use on horseback.

With reference to the question of dress, I think the lecturer has hit several very serious blots existing at the present moment. Our men are dressed for parade, for appearance, for show, and for theatrical effect instead of for work. What gentleman at the present moment in England when he goes out shooting would go dressed in the absurd dress in which a soldier is sent into the field to fight? If we go hunting, shooting, sporting, walking, climbing, or on any kind of wild excursion, we dress for the occasion. Our clothes are made very loosely, and full play is given to all our muscles; but the unfortunate soldier is tied up in a manner that is most unpleasant to him if he has to make use of very great exertion. My experience of a soldier is, that the first thing he does is to take his coat off, and either work or fight in his shirt-sleeves. As far as one can see from general common practice in England, the Norfolk jacket seems to be the most practical dress. A great number of Volunteer regiments have adopted it, and I think most wisely.

With reference to boots, I think the lecturer did not lay sufficient stress upon the fact that people who ride most prefer the long boot with breeches. For the infantry soldier it is different, although the Russians themselves, who are about the best marchers in the world, march in long boots; but I think indisputably for all mounted branches of the Service, long boots and breeches are the best as well as the most comfortable.

Upon the subject of our infantry dress I have two or three remarks to make. First, as to the Oliver equipment, I shall not go into any detailed accounts of it. I am very glad to see it is now going to be very freely tried in the Service. One or two regiments are going to be equipped with it, and in my opinion the sooner it is adopted the better. There are several very excellent things about it; one, by no means the least striking, is the absence of pipe-clay. I think, if there is a monstrous absurdity in the Service, it is the use of pipe-clay. Why you should send a man into the field, where he will have to sleep out of doors exposed to all sorts of

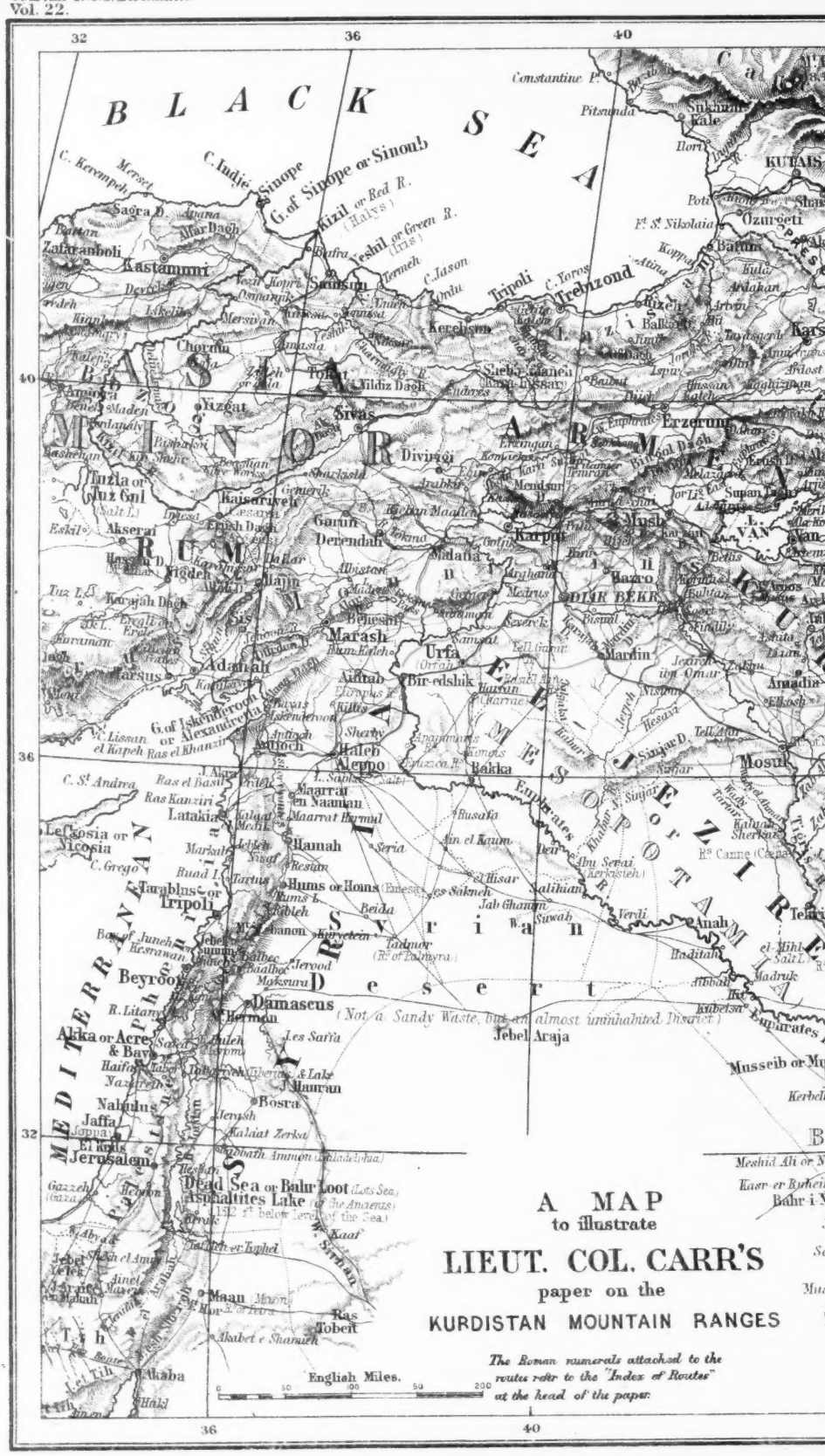
[1] I must add that when I spoke of the American cavalry, I did not mean to compare them with our cavalry as such. I wanted to direct special attention to the results obtained by the use of a certain class of armament. If mounted infantry who were bad riders, but armed with revolvers, gave such a handsome account of regular cavalry who were only armed with the sabre, as in the instances quoted by me in the body of my lecture, how much more necessary it is, therefore, to supply the front ranks of our cavalry all round with revolvers. The writers from whom I have quoted are Jomini, Marmont, De Brae, Woemer, Cromwell, Napoleon, Havelock, Trower, Denison, and Elliott.

weather, dressed up like a scare-crow with white stuff all over him that falls off on the first shower of rain, dirtying his boots and clothes, I cannot understand. I am glad to see in the specimen of the Oliver equipment before us to-day that all the straps are of the natural colour of the leather.

With reference to what has been said regarding the Martini-Henry, I am very sorry I do not know enough about rifle shooting to be able to give any decided opinion. The question, however, put before us by the lecturer, and also by Admiral Selwyn, as to the cartridge, has struck me very recently. The American cartridges are made stamped in one piece, and ours are built up in a complicated way. I regret that no gentleman capable of speaking on the subject has explained how it is that the style of cartridge we have in use has continued so long. As to the shortness of the rifle, I do not share all the objections which have been put forward by the lecturer on that subject. I think the days when men prodded one another with bayonets are past and gone; and I therefore think you should look at the rifle as a thing that shoots, and not as a thing with a bayonet at the end for the purpose of killing with. If the short rifle shoots as well as the long rifle, I think the former should have the preference. The lecturer, however, said the trajectory of the short rifle was not as good as that of the long one. I never heard that before, and I hope he is misinformed. With reference to the bayonet, I certainly have a very strong opinion; as I have just said, I do not think it should be simply regarded as a weapon to kill with. It is, doubtless, necessary to have it for the moral effect, and as you must therefore carry some prodding weapon at your side to put on the end of your musket when you require it, it is very desirable it should be something you can turn to some other use as well. The trowel-bayonet was used in America many years ago during the war; but I do not entertain the very high opinion of it that has been expressed by the lecturer. As a rule, I do not think that things that are intended for so many purposes, generally answer any; and the trowel-bayonet, after being used some time for digging, would be of very little use I think for any other purpose whatever. As one gentleman said it certainly would not cut, and I very much doubt if it would last long as a digging-tool; I have seen experiments carried out with it; to dig a hole large enough to get into, with a trowel whose handle is only six inches long, is a very break-back job. There is a bayonet which will cut and saw wood or meat, and that is the Elcho bayonet. This was at first adopted by some regiments of Volunteers. I saw it used on several occasions, and I must confess that, to my mind, it is one of the most valuable weapons I have ever seen. We used it during the Ashantee campaign, where it was invaluable. You could cut small trees down with it, and it is an efficient and handy weapon for all purposes on the field. I have only one other remark to make, and that is with reference to the lecturer's allusions to the use of cavalry. He quoted the observations of Colonel Denison, and also a work of Sir Henry Havelock's on the subject. Now, Colonel Denison is a very excellent Officer, and a man who has studied the profession most earnestly; but he does not, I think, appreciate fully what real cavalry can do. He has a very intimate acquaintance with cavalry as they existed in America; but I wish to impress upon all here one fact with reference to the use of cavalry during the war in America. It is this: that neither on the Federal side nor on that of the Confederates, had they any regular cavalry at all. They had men on horseback, but they were not cavalry soldiers as I understand cavalry men. They were mounted infantry, and simply mounted infantry: that is, they were infantry soldiers put on horseback. I saw a little of both armies in that war, and as regards the Northern cavalry nothing could be worse; they were very bad horsemen, indeed, in the European acceptation of the term, they certainly were not cavalry. The great feats that we heard of as performed by the American cavalry were really done by mounted infantry. The remarks on the Confederate war, made by Sir Henry Havelock in his book on this subject, were made before he had been in America, or he would not have fallen into the common error of referring to Virginia as a country of plains suited to cavalry. Now, my experience of Virginia is that there are few places where a squadron could charge for 500 yards, as it is a wooded country with numerous fences. I think, ladies and gentlemen, we have had a great deal of very valuable information imparted to us both by the lecturer and by those gentlemen who have taken part in the discussion, and in your name I beg to tender them our cordial thanks.

s off on
. I am
all the

am very
decided
Admiral
rtridges
I regret
t is that
e short-
forward
another
the rifle
purpose
former
ne short
I hope
strong
weapon
l as you
of your
an turn
ears ago
as been
ntended
ng used
purpose
y much
ied out
only six
nd saw
y some
confess
n. We
uld cut
oses on
e to the
Colonel
Colonel
on most
lo. He
I wish
ing the
t of the
ack, but
mounted
put on
orthern
in the
e great
done by
y Have-
a, or he
country
are few
ry with
of very
ntlemen
hem our


BLACK SEA
MEDITERRANEAN SEA
ASIA MINOR
RUM
ARMENIA
KURDISTAN
MESOPOTAMIA
SYRIA
Desert
(Not a Sandy Waste, but an almost uninhabited Desert)
Constantinople
Sinope
C. Indje
G. of Sinope or Sinoub
Kizil or Red R. (Halys)
Eshil or Green R. (Iris)
Trebizond
Tripoli
Samsun
Kastamuni
Zafaranboli
Amasia
Tokat
Sivas
Yuzgat
Kaisarieh
Akserai
Erzerum
Erzingan
Divrigi
Mendsun
Karput
Musha
Bitlis
Van
Lake Van
Bazro
DIAR BEKR
Mardin
Urfa
Marash
Adamah
Tarsus
Aintab
Bir-edshik
Haleb
Aleppo
Bakka
Mosul
Nisibin
Jezirah ibn Omar
Amadia
Sinjar
Khabur R.
Euphrates
Tigris
G. of Iskenderoon or Alexandretta
Antioch
Latakia
Maarrat en Naaman
Maarrat Hermul
Busafa
Ain el Kaum
Hamah
Seria
Hums or Homs (Emesa)
Tarablus or Tripoli
Jebel Lebanon
Beida
Jab Ghamun
Suwah
Anah
Verdi
Salihiah
Abu Serai
Beyroot
Damascus
Mt. Hermon
Jebel Araja
Akka or Acre
Haifa
Nazareth
Tiberias & Lake
Jaffa
Nablus
Bosra
Jerusalem
Dead Sea or Balur Loot (Lots Sea, Asphaltites Lake (of the Ancients) 1292 ft. below level of the Sea)
Jebel Kaaf
Maan
Ras Tobeit
Akabet e Shamieh
Tih
Akaba
Cyprus or Cyprosia or Nicosia
Meshid Ali or Najef
Musseib or Mussaib
Kerbela
Euphrates
Tigris
A MAP
to illustrate
LIEUT. COL. CARR'S
paper on the
KURDISTAN MOUNTAIN RANGES
The Roman numerals attached to the routes refer to the "Index of Routes" at the head of the paper.
English Miles.
0 50 100 150 200
32
36
40

Stanford's Geog.l Estab.t London

THE KURDISTAN MOUNTAIN RANGES, CONSIDERED IN REFERENCE TO A RUSSIAN ADVANCE ON THE TIGRIS VALLEY.[1]

By Lieutenant-Colonel RALPH E. CARR, 36th Regiment.

PART I.

Index of Routes.

No. 1. Mr. Brant.
„ 2. Mr. Taylor.
„ 3. Ditto.
„ 4. Ditto.
„ 5. Mr. Brant.
„ 6. Paul Lucas.
„ 7. Von Moltke.
„ 8. Mr. Taylor.
„ 9. Mr. Brant.
No. 10. Lord Pollington.
„ 11. Colonel Shiel.
„ 12. Mr. Ainsworth.
„ 13. Mr. Layard.
„ 14. Mr. Taylor.
„ 15. Mr. Layard.
„ 16. Mr. Layard.
„ 17. Mr. Ainsworth.

At a time when the attention of military students is directed to the movements of the opposing Russian and Turkish armies in Asia Minor, a fitting opportunity presents itself to examine, by the aid of the map and by the experience of travellers, the serious nature of the obstacles likely to be opposed to the further progress of Russian arms towards the Tigris and Euphrates Valleys.

I must here disclaim all pretension to offer to the frequenters of the Royal United Service Institution information which they can obtain by reference to the travels of which this paper is mainly a compilation, but my object has been to bring within a small compass the experience of a number of travellers, for the benefit of those members of the Society, and of the military profession generally, who, being scattered in remote stations, have not the command of works of reference, some of which have long ceased to be in general circulation; as the exploration of the mountains of Kurdistan (which was carried on with considerable energy in the earlier half of the century) seems, with the exception of Mr. Taylor's, Baron Von Thielman's and lastly Captain Burnaby's contributions, to have been almost discontinued since the Crimean War.

The great mountain system, extending in almost unbroken continuity from Iskanderoon on the Mediterranean to the Persian Gulf, has (hitherto) perhaps derived its chief interest in modern times from its bounding to the north the rich plains of Mesopotamia, and from its slopes being drained by, and supplying the sources of, "that great river, the River Euphrates."

It seems now destined, within the lifetime of the present generation, to attract the notice both of the statesman and of the soldier, from

[1] This paper was chiefly compiled in 1877.—ED.

its position between the tide of Russian advance and the waning power of Turkey.

In order to condense as much as possible the information afforded by a number of authorities, I have thought it more satisfactory to quote verbatim from each some of the most instructive passages bearing on the lines of communication and the relation between the several sects, even at the risk of wearying the reader by a series of extracts.[1]

While avoiding as far as possible the temptation to follow the authors into subjects of general interest, I trust that the references here given may perhaps assist some of my readers to study for themselves the physical geography of a country likely to play an important part in the history of the East.

I propose first to confine my attention to the western half of the range comprised within the present limits of the Turkish dominions, and therefore more directly affected by the course of the war now raging.[2]

In considering this subject, it is here assumed that the war has brought such successes to Russia, that Erzeroum has been occupied, and her frontier, or the territory under the command of her armies in Armenia, has advanced so far as to be represented by a line drawn from Trebisond on the Black Sea, including Gumish Kaneh, and Baïbut, but leaving Erzingan to Turkey; then crossing both branches of the Euphrates to the mountain range which forms the southern boundary of Lake Van, and so on to the Persian frontier near the head waters of Zab-Ala tributary of the Tigris.

All this country, except the basin of Lake Van, was overrun by Marshal Paskiewitch in his brilliant campaign of 1829; and should it again fall into the power of Russia, it can scarcely be supposed that the large Armenian population will ever be handed back to the tender mercies of the Turk.

Once again in possession of Erzeroum and Bayazid on the bleak highlands of Armenia, Russia is not likely long to withhold her grasp from Van, the acquisition of which territory is of obvious strategical importance, as carrying her forward at one step 200 miles to the southward and securing as an outpost, from which to choose her own time for the next move, one of the most favoured districts of Asia, the reputed cradle of the human race, and unrivalled in fertility of soil and salubrity of climate by any part of the world.

The far-famed vale of Cashmir, perhaps, approaches nearer than any other district to the following description of Van by Major Millingen, who commanded a Turkish force on the Persian frontier at Kotur after the Crimean War.

("Wild life among the Khoords," by Millingen, p. 152.)—"Nature has been liberal in its gifts to the District of Van, having endowed it with all the elements

[1] It will be seen, from the same proper name being often spelt in two or three different ways, that I have retained, in each case, the orthography adopted by the author in the original.

[2] Written 16th January, 1878.

which can ensure prosperity and abundance. Its climate is mild, the severe winters which visit Erzeroum being unknown here. The thermometer rarely falls to 14° Fahrenheit, whereas the utmost heat does not reach higher than from 86° to 95° Fahrenheit in the sun.

"The soil is fertile and capable of producing anything . . . .

"The apple, the pear, the cherry, the apricot, the fig-tree, the vine, abundantly supply the country with their fruits; while the shade of the lime-tree, the willow, poplar, elm. and mulberry protects it against the heat of the summer. All the varieties of vegetables which are to be found in the kitchen-gardens of Constantinople are, with one or two exceptions only, supplied by the gardens of Van. Wheat and barley are plentiful in the districts surrounding the lake . . . .

"The flocks of numberless sheep, bred by the Kurdish shepherds, not only supply the country with meat, wool, butter, and cheese, but also provide the larger markets of Asia Minor, Syria, and Constantinople with the means of subsistence."

Although by the scope of this paper we are only directly concerned with the communications from Van to the southward, it may not be out of place to mention here that Mr. Brant passed over the Ala-Tagh Range in 1838, and past the sources of the Murad Su Euphrates, by a steep ascent and an almost precipitous descent through Diyadin to Byazid; and that Texier reached the latter town from Van by a route more to the south.

A recent and important addition to the geography of the Van basin is found in Captain Burnaby's journey last winter from Ardish, on the northern shore of the lake, over the eastern spurs of the Sipan Dagh Mountain to Patnos on a tributary of the Murad Su Euphrates. Thence, avoiding the more beaten track by Malazgerd, he passed by an hitherto unexplored country, ascending the course of the Murad Su through the Ala Dagh range to the main Erzeroum and Bayazid road, where he narrowly escaped paying the penalty of his enterprise with his life from an attack of fever.

Van has also direct communication with Persia through Kotur and Chöi, which route has been followed by Texier, Major Millingen, Colonel Shiel, Captain Burnaby, and Dr. Otto Blau. The latter, however, diverged from Kotur southwards to Dilman by a comparatively easy road, past Chani, or Chanzi, at the sources of the Zab-Ala.

From thence he mentions that the most direct, but most difficult, road to Van leads, through a country hitherto unexplored, to Choshab. There it joins the route taken by Mr. Layard from Bash-Kala, in 1850, as hereafter noticed.

After this digression, I will now ask my readers to accompany me on the map along the main road from Erzeroum southwards, which leads through Cnys, or Kenys, the most southerly point occupied by the Russians in 1829, to Mush, the capital of a Pashalic near the Murad Su branch of the Euphrates, and thence close past the shores of Lake Van to Bitlis. The road then passes out of the basin of Lake Van, through narrow defiles, which will be treated of hereafter, to Til on the Tigris, and it has formed through all ages one of the chief trade routes from Trebizond on the Black Sea, to Mosul or Nineveh on the Tigris.

Mr. Layard thus describes the route to the north of Bitlis:—

"Here and there the ruins of a fine old khan, its dark recesses, vaulted niches and spacious stalls, blackened with the smoke of centuries, seemed to mark one of the

great highways leading in the days of Turkish prosperity from Central Armenia to Bagdad. We had crossed this road on the plain of Hinnis (Chynys). It runs from Erzeroum to Mush, and thence to Bitlis, leaving to the east the Nimroud Dagh, which separates it from the lake of Van. Commerce has deserted it for very many years, and its bridges and caravanserais have long fallen into decay; when, with the restoration of order and tranquillity to this part of Turkey, trade shall revive, it may become once more an important thoroughfare, uniting the northern and southern provinces of the empire."

These khans attracted the special notice of Mr. Brant, who thus accounts for their number on this route ("Journal of Geographical Society" vol. x, p. 379):—

"In the course of our descent to Bitlis we met several large khans of very solid construction, but in a ruined state, and so near each other that I was at a loss to imagine the reason, until I learned that in winter in this pass the wind often rushes through the valleys with fearful violence, and, when accompanied by snow, endangers the lives of persons on the road, for advance or retreat are then equally impracticable. The khans were built to afford refuge to caravans or travellers caught in these storms, and the peasantry were bound to resort thither on the approach of bad weather, to be at hand as well to give assistance as to furnish supplies during the detention of persons, and to open a way through snow-drifts for their release. The ruin and neglect of these useful buildings and customs, is a proof of the decay of trade and of the indifference of the local governors to the welfare of the people."

This road was followed, almost throughout, by the 10,000 Greeks in their celebrated retreat from Arbela to Trebizond, and was the scene of their almost daily encounters with the Carduces, the ancestors of the present Kurdish tribes. From Bitlis there is communication both by the lake and by land with Van, the capital of the Pashalic and the centre of an important Armenian community.

The town of Bitlis itself is situated on the banks of a tributary of the Tigris; but being only a few hours distant from Lake Van, from which it is easily accessible, while it is separated from the Tigris Valley by deep gorges and rugged passes, it would appear destined to fall under the power which shall in future hold the former rather than the latter basin.

The frontier so rectified would show Russia in occupation of the head waters of both branches of the Euphrates, and of the basin of Lake Van, together with the most considerable towns of Armenia, all connected by an historical highway: and thus directly threatening the two most important strategical positions on the Upper Tigris, viz., Diarbekr and Mosul.

From this general forecast of Russia's future frontier towards the Tigris and Euphrates, let us proceed to the consideration of the passes and routes leading to the plains.

Beginning with Diarbekr, as Russia's most westerly objective point, we find that it is separated from Erzeroum by a part of the Anti-Taurus range, known by the local names of Bingol Dagh, Khosma Dagh, Dushook Dagh, and Mesoor Dagh, which occupy the whole country between the northern and southern branches of the Euphrates for upwards of 150 miles above their junction. And that caravans have been obliged for several centuries to follow the

circuitous routes, either by Mush to the east or by Egin and Kharbut to the west.

With the latter route I propose to begin this notice, as being the most westerly line of communication between Erzeroum and the valley of the lower Euphrates, and I will quote the authority of Mr. Brant, British Consul at Erzeroum, who made the journey to Diarbekr in 1835 ("Journey through Armenia and Asia Minor"—"Journal of Geographical Society," vol. vi, p. 201):—

Route 1. "The distance from Erzeroum to Karghan may be about 50 miles in a west-south-west direction. Between the plains of Terjan and Erzingan a mountain range intervenes with many very strong passes easily defensible. It is inhabited by Kurds, and forms part of the Dujik range. The river makes a circuit far into the mountains. Its channel is said to be full of rocks and rapids. It rejoined our route as we entered the plain of Erzingan. The Dujik mountains are peopled solely by Kurds who inhabit villages in winter and cultivate the land. They are represented as rich, pay no sort of contributions to the Sultan, lose no opportunity of levying them on passengers they meet, and are in the constant habit of plundering their neighbours . . . .

"The climate here (Erzingan) is never severe in winter, and it is warmer than that of Erzeroum in summer.

"The harvest was ready (6th July) for the sickle, and the season was rather more backward than usual. On the northern side of the plain the bases of the mountains bounding it are covered with villages, surrounded by very extensive gardens, which furnish, in great abundance, excellent fruit to the circumjacent districts, even as far as Erzeroum, Baibut, and Gumish Khaneh. Grapes and melons are among the fruits produced. The fields bore the most abundant crops I had anywhere witnessed. The wheat was heavy and the straw much longer than in the Erzeroum plain . . . In no part of Asia Minor did I see a plain with more luxuriant vegetation, nor the appearance of more careful cultivation.

"Crossing the plain in a southerly direction, in about an hour and a-half we entered a very narrow defile through which the Kara Su flows. This defile in its whole length to Kemach is very strong and presents innumerable defensible positions. The river was on my left, running at the foot of the Dujic mountains; on my right were mountains all but precipitous. The river is fordable in one or two places, with some difficulty, during the dry season. It took me ten hours to go from Erzingan to Kemach, but from the nature of the road I should not conceive the distance to be above 26 miles.

"I entered Kemach by a bridge of wood thrown over a deep chasm in the mountain through which the river has forced its way . . . .

"On quitting Kemach I recrossed the bridge by which I had entered it and took a course more westerly than the river, crossing mountains which here and there presented strong positions . . . . . .

"After crossing to the left bank of the river, I continued along it for about three miles, till I reached a village below which the stream again enters a vast rent in the mountains, the precipices on either side rising to 1,000 or 1,500 feet . . . . . There is said to be a better, though a longer, road by keeping along the right bank of the river, but it could only be better by comparison—good it could not be . . . . .

"After quitting Egin, we continued on the western bank of the river, but instead of following the windings of the stream we crossed several steep mountains and deep valleys. The road is less difficult than that by which I approached Egin . . . .

"The distance from Egin to Arabgir may be about 30 miles in a direction first south and then south-west. There was stated to be a better road from Hassan Ovah, avoiding Egin and keeping at a distance from the river . . . . .

"The road from Arabgir to Kebán Maden lies over an undulating, open, barren, and uncultivated country, affording only a scanty herbage to a few cattle and sheep. Between Arabgir and the Euphrates, a distance of about twenty miles, I passed but one village with a little cultivation around it. Before reaching the river, I fell into the military road, constructed from Samsun by order of Reshid Mohammed Pasha:

it appeared to have been made with too great haste and too little labour to promise durability. I crossed the Euphrates by a ferry; there are three boats, clumsily constructed but adroitly managed. The stream is about 120 yards wide, deep and rapid.

(P. 208). "Descending from the eminence on which the town of Kharput is situated we crossed the plain in an oblique direction, and ascended a very steep mountain, on the face of which the military road has been continued, but the passage is still very difficult, on account of the extreme rapidity of the ascent, which it took us two hours to accomplish . . . .

"We then crossed a beautiful but small plain with two villages in it, and soon engaged in a succession of very difficult mountain passes; here all traces of the military road are lost. In these barren mountains are situated the sources of the Tigris and the copper mine of Aghana . . . .

"From the mine to the town, a distance of about ten miles, in a direction to the eastward of south, the road lies over steep, difficult, and barren mountains."

I have dwelt at such length on the conditions of this road because it is the main trade route from Erzeroum and Erzingan, not only with Diarbekr, but with Aleppo and Syria.

From the survey of the Kara Su valley let us turn to the mountain track, noticed above, separating it from the southern or Murad Su branch.

Upon this district, until then supposed to form an impenetrable barrier and inhabited by savage tribes, Mr. Layard, our present Ambassador at Constantinople, was the first to throw light in the following passage ("Nineveh and its Remains," p. 9):—

"With him" (Mr. Brant, British Consul at Erzeroum, 8th September, 1848), "I visited the Commander-in-Chief of the Turkish Forces in Anatolia, who had recently returned from a successful expedition against the wild mountain tribes of Central Armenia . . . .

"His last expedition had been the subjugation of the tribes inhabiting the Dudjook mountains, to the south-west of Erzeroum, long in open rebellion against the Sultan. The account which he gave me of the country and its occupants much excited a curiosity which the limited time at my command did not enable me to gratify.

"According to the Pasha, the tribes are idolatrous, worshipping venerable oaks, great trees, huge solitary rocks, and the grand features of nature . . . .

"The direct road between Trebizond and Mesopotamia once passed through their districts, and the remains of spacious and well-built khans are still seen at regular intervals on the remains of the old causeway. But from a remote period the country had been closed against the strongest caravans, and no traveller could venture into the power of tribes notorious for their cruelty and lawlessness.

"The Pasha spoke of re-opening the road, re-building the caravanserais, and restoring trade to its ancient channel."

Nearly 20 years elapsed without anything more being heard in England of this most important district till Mr. Consul Taylor of Diarbekr communicated in 1868 to the Geographical Society the result of his explorations.

Route 2. Leaving Erzengan Mr. Taylor made his first march to Philamier at the foot of the snow-capped Deyrism Hills, which seemed to bar all further progress. From this point the road is described in the following abstract ("Proceedings of Royal Geographical Society," vol. xii, p. 203):—

"From Philamier Mr. Taylor was surprised to find a good road, though hilly in parts, leading through the Koozichan district as far as the Deyrism range, through which, though popular error represented it as inaccessible, a remarkably easy route

exists all the way to Masgerd, never he believed, since the days of the Seleucidæ, traversed by civilized beings, and which the jealousy of the Kurds had hitherto concealed from foreigners—for the obvious reason that the former do not wish it known that so easy a route exists through their formidable mountains.

"It passes through undulating valleys, studded with thriving villages, and the country on either side is beautifully wooded with oak, pine, and poplar, and opens here and there into fine level, well-watered plains. Two considerable affluents of the Mezoor Su, that great tributary of the Tigris, rise in these valleys . . . .

"These valleys are inhabited by a numerous population of Kurds . . . . The Kurds appear well off, and the seclusion which they enjoy protects them from the impositions and taxes laid on their less fortunate neighbours."

Route 3. Besides this long forgotten and important route, Mr. Taylor explored in 1866 two other tracts through Deyrism. One of these crosses the Kara Su Euphrates by a bridge at Erzingan, ascends the Mesoor Dagh by the course of the Boghaz river to the Sakkal Tuttan, or "beard plucking" (so called from the robberies committed there), then crosses the Mesoor Su and reaches Kozat in five marches, where there is a permanent Turkish barracks, occupied by 600 men and 6 guns.

Route 4. The other route crosses the Kara Su by a bridge at Komach, 20 miles below Erzingan, passes the Mesoor Dagh by the Ziarat pass, 8,000 feet high, which was found so difficult that the mules had to be unloaded and the baggage carried by hand for some distance. This route joins the last-mentioned at Kozat in four marches.

The tenor of these two itineraries shows that these last-named roads can only be regarded as subsidiary lines of communication.

But it will be seen from the survey of these four passes, connecting the valleys of the nothern and southern Euphrates, that the northern entrances are all commanded by the town of Erzingan, which thus becomes a position of vital importance to Turkey against an enemy advancing southwards from Erzeroum.

From Mr. Taylor we gain the first authentic information regarding the strange religious tenets of the pagan Yezede or Kissilbash tribes of the Dujook Dagh, alluded to by Mr. Layard, and their hatred to the orthodox Mussulman (See also Mr. Brant, "Journal of Geographical Society," vol. x, p. 354).

His paper further establishes the fact, that not only is the Murad Su Euphrates navigable for rafts from its junction with the Mezoor Su above Peyrtek to the silver mines of Kebban Maaden, but that the latter tributary is also navigable for some distance into the hills, as corroborated below by Von Moltke.

Route 5, *Mr. Brant.*—Next in order to the eastward comes Mr. Brant's return journey (p. 366), in company with Dr. Dickson, in 1838, from Kharput to Mush, following the left bank of the Murad Chai to Palu, where he passed to the northern bank by a rickety bridge, fixed on the old stone piers. There is nothing of special interest in this road to the point where it joins that taken by Mr. Taylor two marches further east (Route 8), but the fact that Mr. Brant was encumbered by a large part of his attendants being so prostrate from fever that they had to begin the journey in arabas, proves that the road must have been an exceptionally good one.

But the most important fact is established that Mr. Brant travelled for five miles out of Palu, on the direct road to Erzeroum, though his notice of it is unfortunately confined to the following lines (p. 368):—

"The direct road to Erzeroum is closed by snow during three months; the distance is eight caravan days and 42 post hours."

This is, as far as I am aware, the only notice by a recent traveller of one of the most important routes in Armenia, for an account of which we must refer 170 years back to the narrative of Paul Lucas, who travelled on behalf of the King of France in southern Armenia, shortly before Tournefort's visit to the districts of Erzeroum and Kars. In the short interval which elapsed between the peace of Ryswick and the war of the Spanish succession, the Grand Monarque appears as the patron of these pioneer explorers.

How complete was the ignorance till then prevailing of the outlines of Armenian geography is proved by the fact that when Paul Lucas followed a tributary of the Murad Su Euphrates from Palu to its source, and then crossed the watershed to Melican on a tributary of the northern, or Kara Su, branch, he in each case believed himself to be on the main stream, and did not discover his error even when compiling his narrative, as shown by the following extract ("Voyage au Levant," Paul Lucas, à la Haye, 1700, vol. i, p. 196):—

Route 6, *September* 11*th*. "The mountains over which we passed were strewn with large round stones, which caused our horses to stumble every moment. After having descended a high mountain, we arrived near a village situated in a fine plain, where we encamped.

12*th September*. "After twelve hours of fatiguing march, always in high mountains, covered with shrubs and oaks, which bore large acorns, we encamped at the foot of one of these mountains near the Euphrates.

13*th September*. "A similar road over mountains which extend along the river. These heights are passed by a little path cut in the rock, over which, on overhanging precipices, eagles built their nests.

14*th September*. "After six hours' marching along the Euphrates, which we forded four times, owing to its windings, we passed by precipices so terrible, that they must be seen to be imagined. Conceive a wall of rock, higher than the towers of Notre Dame at Paris, along the banks of the Euphrates over which there is only a little path a foot in width, and in many places broken away, and so slippery that if one made the least false step he would fall into the precipice. It was a wonder that our horses and mules escaped. We passed the Euphrates on a bridge of only two arches, and, after having ascended a highish mountain, we encamped on its summit, surrounded still by very high mountains.

15*th September*. "We did nothing but descend, during seven hours, after which the Euphrates is again forded, the water being low at this season. The river was almost nothing at this spot, and sometimes it only appeared a rivulet. We encamped about a quarter of a league after having passed the Euphrates near a village named Melican, where also another caravan was halted, which was going to the slave market at Erzeroum."

From Melican he found the journey a "promenade on good roads among small hills to Erzeroum."

Paul Lucas describes the town of Palu as—

"Situated on a hill very steep on all sides, with narrow streets running along the edge of frightful precipices. There is also on the top of the rock sufficient soil to support a small garrison. The Euphrates passes along the foot of the town on one side, and its situation has rendered it impregnable to the very large armies which the Grand Seigneur has sent against it, and which have only been paralysed there."

The eminent German geographer, Karl Ritter, gives ("Comparative Geography" by Karl Ritter, vol. vii. p. 717), on Niebuhr's authority, which has also been accepted by Dr. Kiepert, a direct route of five marches from Palu to Diarbekr; and the fact that it is the point at which the two last-mentioned roads meet, viz., those from Erzingan and Erzeroum, and that it commands the valley of the Euphrates, constitutes Palu a most important strategical position.

Let us now cross to the southern bank of the Murad Chai, and follow the route from Palu to Hazru, which was traversed by Captain (now Field Marshal Count) Von Moltke in company with Hafiz Pasha in 1838. His narrative ("Zustände und Begebenheiten in der Turkei," Von Moltke, Berlin, 1875 (Condition of and Occurrences in Turkey), p. 287), is unfortunately very meagre regarding the nature of the road.

Having arrived the previous day from Mayafarkin to the eastward, he writes:—

"On the following day we rode through the mountain to Ilydscha, and at four in the evening after a forced march, we arrived at Sivan Maaden. Only the best horses kept even near the excellent Arab mare of the Pasha; full the half of his train were left behind, and the worst part of them sank under the effort. Scarcely could a richer iron mine be found, or one easier to work than this. You need not go under the surface of the earth, for hills and valleys are covered far and wide with small and large blocks of stone of a black colour. You need only take these stones in the hand to be quite convinced by the mere weight of them how full of metal they are.

"While we rode up one of the affluents of the Tigris we reached the high watershed between this stream and the Euphrates or Murad; but it is very surprising how near the sources of the former and the banks of the latter lie, at a place moreover where it has grown into a great stream. The interval scarcely amounts to more than 1,000 or 1,500 paces."

Regarding the descent to the banks of the Euphrates from the watershed, Von Moltke is unfortunately silent, but the omission is partly supplied by Von Mülbach, as cited by Karl Ritter ("Comparative Geography," vol. vii, p. 710):—

"From Palu Von Mülbach, after a march of six hours, on the road to Sivan Maaden, pitched his camp, on 18th February, at the Kurdish village of Akrakli lying close to the southern bank of the Euphrates. The path from thence ran partly along the slope of the banks of the Murad, and was dangerous to pass in consequence of the still frozen places, and the cascades which spouted from the precipices on the southern faces of the mountains.

"On 19th February he could only climb on foot to the watershed between the Murad and the Tigris, to the village of Sheik Ismael-an, in order from there to reach Sivan Maaden, for which eight hours were required, on account of the still deep snow, and the absence of any track over the mountain tops, although the distance is only half as much."

Karl Ritter attaches the highest importance to the iron mines of Sivan Maaden as furnishing abundant supplies of iron for the future defence of the fortress of Diarbekr (vol. vii, p. 711); and Von Moltke shows the possibility of, but the dangers attending the navigation of the Euphrates in his narrative of his descent from Palu to Samosata on a raft, a distance of about 400 miles, down a succession of dangerous rapids, which may perhaps be regarded as not the least adventurous exploit of an eventful career (p. 289).

Route 8. Passing on to the east, we find from Mr. Taylor's paper, communicated to the Geographical Society (p. 448), in 1865, that Diarbekr has communication with Mush by a road which, descending the Murad Su Euphrates from the latter town, passes to the right or northern bank, then following the fruitful Boglan Valley, and over the Tchabakchoor plain, crosses again at Dyg to the southern bank. Mr. Taylor is unfortunately silent as to the character of this road from the channel of the Murad Su to the head-waters of the Dibeneh Su tributary of the Tigris; but from the fact that he dwells on no difficulties such as he encountered in Routes 3 and 4, while matters of archæological or geological interest are fully detailed, we may infer that the obstacles encountered were less serious.

From Heyni to the town of Dibeneh he describes the road as "running through the beautiful valley of Pelishka, close to the low range of hills that bound the valley of Nerib on this side. It is inhabited by a set of Kurds (always in rebellion) living in their secluded and inacessible valley, which still contains several ruins of a very ancient date."

From the pretty little town of Heyni, Mr. Taylor went, by a well-populated country and frequent villages with extensive ancient ruins, to the town of Khuzru, at which also converge the track followed by Von Moltke from the head-waters of the Dibeneh Su, and also that taken by Lord Pollington over the Chulp Dagh Pass, and through Nerjki.

Kazru seems therefore to be a place of considerable strategical importance, as the point of junction of three passes leading north, and also that to the east by Mayafarkin and Arzen to Sart and Bitlis; and also from its situation in the great undulating plain extending from the Tigris to the Garzan Dagh, with direct communication with Diarbekr and Maaden.

We have already noticed in Route No. 5, Mr. Brant's return journey from Karput to Mush, in 1838. On his journey to Karput, which we have now to consider, he chose the more rugged and less frequented track which crosses the mountains directly to the south from Mush, and joins at Heyni Mr. Taylor's Route No. 8, last described.

Route 9 (*July 3rd*, 1838, "Journal of Geographical Society," vol. x, p. 354). "From Kizil Arghai we ascended the mountains. After reaching the summit of the first range, called Koshm Tagh, at about 6,800 feet we saw two others; the highest, named Antogh Tagh, had a good deal of snow on it, but it does not remain all the summer; this mountain appeared the centre of the group, the ranges on each side being lower . . . We descended into a deep ravine, and after a few ascents and descents, not very long nor steep, reached a valley called Shin . . .

(*July 4th*). "Immediately on mounting, we commenced ascending the Darkush Tagh. It took us one and a half hour to reach the highest part of the range, which we crossed at 6,490 feet above the sea, and immediately commenced the descent by the most difficult path I ever went over; sometimes it led us round precipitous hollows in the hills; sometimes it came down, in a zig-zag, the face of a nearly perpendicular rock; our horses, though led, often slipped off the uneven narrow path, and risked being precipitated into the abyss, perhaps, 1,200 feet in depth, and it was by great caution alone that a person, even on foot, could keep his path . . . After a difficult and fatiguing walk of two hours (for riding was seldom possible) we found ourselves opposite to the high ridge we had crossed, and scarcely a mile distant from it. We waited two hours for our

baggage to come up, fearing the muleteers might require assistance. We then proceeded winding along the mountain sides by paths very little better than those just described . . . At seven o'clock we reached the village of Nerjki. The distance we had come was called eight hours by the Kurds. We had been ten hours riding and walking, besides many long stoppages for our baggage . . . I never met in my travels so difficult and dangerous a pass; the passage of troops could be easily arrested by a small force, and it would be quite impossible to drag artillery over it. Yet I was told the Kharzan mountains are still more impracticable, and that no loaded animal except a mule can traverse them at all."

From Nerjki, Mr. Brant took the road due west to Aghana Marden, passing through Ilijeh, Khini, and Zibeneh. This road seems to be of secondary strategical importance. The local Begs had all been recently brought into subjection to the Porte by Reshid Mohammed Pasha, and in Mr. Brant's "opinion, the people now enjoy the most perfect security, which they never could ensure for an instant under the former system."

Route 10. Lord Pollington ("Viscount Pollington from Erzeroum to Aleppo," Journal of Geographical Society, vol. x), had preceded Mr. Brant by only three weeks, crossing the Darkoosh Tagh on 12th June. He was hospitably entertained by the Yezedi tribe at the foot of the pass, and then crossed by a road which he describes as "execrably bad throughout."

Passing on further eastward we come to the main road connecting Bitlis, near the south-western corner of Lake Van, with the Tigris Valley, which has been already alluded to as the old historic trade route from Mosul (Nineveh) to Erzeroum and the Black Sea. It may perhaps be more correctly described as a group of passes, for below Bitlis three roads diverge, two of which cross the Ali Tagh Mountain near together at the Dezej Tasul Pass, which Mr. Ainsworth gives as 5,120 feet. The third, more to the west, which passes through Warchan was followed by Colonel Shiel ("Geographical Society Journal," p. 73), in 1836. He describes it as follows :—

Route 11. "We proceeded (from Bitlis) at first down the left bank and then passed over to the other side by one of the numerous neat stone bridges by which it is crossed. The road lay through the narrow defile which is formed by the stream, and was the worst, if not the only really bad one we encountered. The path was high above the bank, sometimes so narrow as scarcely to give room for the horses' hoofs, and at times so impeded by large stones that our progress did not exceed one mile an hour. At about the fifth mile, the road was crossed by a high ridge of rock which reached the stream. Instead of carrying the road over it, an opening was cut through the solid rock of 15 ft. in width and height, and 20 in length. (P. 74) We met a caravan of mules proceeding from Bitlis to Shirwan, said to be eight hours south-east, with salt . . . At the 16th mile we crossed over a stone bridge to the left bank of the stream, which was rapid and deep, though not more than twelve yards in width. At about the twentieth mile we ascended a high mountain in a southerly direction, and left the river, which flowed to the west. The ascent was most fatiguing to our exhausted cattle. We then descended at 8 P.M. to the district of Warchan, completely worn out . . . Although we had been ten hours on horseback, I do not think we had travelled a greater distance than twenty-six miles; yet so great was the fatigue that I doubt whether the horses ever recovered from the effect of it."

Route 12. Mr. Ainsworth ("Ainsworth's Travels in Asia Minor," p. 365), who took the more easterly route by Kufra, though acknowledging difficulties, seems to have regarded them as trifling

after what he had encountered in the Nestorian districts of the Zab-Ala.

"At Kufra (going northwards) commences the most difficult pass which the mountains present on this line of road, and which Kinneir describes as the worst he met with. What would he have said to the passes in the Tiyari country? It is carried along the side of a hill composed of sandstones, with limestone forming cliffs above."

The distance from Bitlis to Til at the junction of the two branches of the Tigris is estimated at from 64 to 80 miles.

Mr. Layard ("Nineveh and Babylon," p. 37) pronounces the following opinion on the merits of the several routes from Bitlis:—

"There are three roads from Bitlis to Jezireh, two over the mountains near Sert, generally frequented by caravans, but very difficult and precipitous; a third more circuitous and winding through the valleys of the eastern branch of the Tigris. I chose the last, as it enabled me to visit the Yezedi villages of the district.

Route 13. "We left Bitlis on 20th September. Soon issuing from the gardens of the town, we found ourselves amidst a forest of oaks of various descriptions. It was one of those deep, narrow and rocky valleys abounding in Kurdistan, the foaming torrents dashing through it, to be crossed and recrossed, to the great discomfort of the laden mules, almost at every hundred yards, and, from want of bridges,[1] generally impassable during the spring and after rains . . . .

"Several bridges and spacious khans, whose ruins still attest the ancient commerce and intercourse carried on through these mountains, are attributed, like all other public works in this country, to Shah Murad, during his memorable expedition against Bagdad, A.D. 1638. About five miles from Bitlis the road is carried by a tunnel about 20 feet in length through a mass of calcareous rock, projecting like a huge rib from the mountain's side.

"There are many such in the mountains,[2] and the remains of a causeway, evidently of great antiquity, in many places cut out of the solid rock, are traceable in the valley.

(P. 63.) "The direct and most practicable road (for the 10,000 Greeks) would now have been along the river banks to Bitlis. That by Sert is over very precipitous mountains and is only now taken by caravans, because it is more secure than the others and leads through a town where there is some trade."

Mr. Layard reached Redwan, where these three routes join, in five marches from Bitlis. From Redwan and Til, roads branch off in all directions to Diarbekr in the west and to Mosul in the south-east.

The strategical importance of Diabekr to an army operating from Erzeroum and Van towards Aleppo and Mosul, can scarcely be overestimated, and Colonel Chesney's description ("Chesney's Euphrates and Tigris," p. 15) of its former commercial importance is of interest as showing its future capabilities under fair conditions.

"Diarbekr in its prosperity contained 40,000 inhabitants, with numerous cotton looms constantly at work, and it enjoyed an active trade in gall nuts, not only with Kurdistan but also with India on one side through Bagdad, and with Europe through Aleppo on the other."

Colonel Chesney's testimony is amply confirmed by that of Mr. Brant ("Journal of Geographical Society," vol. vi, p. 209):—

"The town (Diarbekr) in its prosperity contained 40,000 families, or houses, and numberless looms in constant work; it enjoyed an active trade with Bagdad in Indian, and with Aleppo in European produce, and was one of the most flourishing

[1] Bridges found in good order by Colonel Shiel, see above, in 1836.
[2] See Colonel Shiel's Memoir above.

and wealthy cities in Asia. The plain was cultivated in every part and covered with villages, and within three miles of the gates there were several villages, each containing from 400 to 500 houses, and more than one Christian Church. At present the number of houses or families in the city is reduced to about 8,000; there exist but a few hundred looms, half employed; the trade with Bagdad is annihilated, and that with Aleppo is reduced to insignificance . . . . All this desolation and depopulation was produced by the Kurds, and that too in the memory of my informant, within 25 years.

"The situation of Diarbekr is admirably calculated for that of a great commercial city, and, nothing appears necessary to revive its ancient importance but a removal of the causes which have produced its decline, namely, insecurity and the interruption of its communication with Bagdad."

Passing still further east, we find that the mountain range separating Lake Van from the valley of the Tigris, was, till visited by Mr. Taylor in 1862, one of the least known parts of the great chain.

Route 14. Mr. Taylor, in ascending the Bhotan Su Tigris from Sert, reached Kosheyer, the capital of the Möx or Mukus district, which Mr. Layard gives below as three marches, in seventeen hours ("Journal of Geographical Society," vol. xxxv, p. 47) "through splendid, wild mountain scenery," passing two large Christian villages,

"Situated on either side of a deep ravine absolutely choked with enormous walnut-trees, and luxuriant fruit gardens and cultivation . . . Each bend of the river reveals new beauties, and the traveller while contemplating these charming and peaceful-looking spots, can hardly reconcile their existence with the lawless character of the savage country and of the people who tenant them. A closer visit, however, dispels much of this delightful illusion and reveals a state of poverty, wretchedness, anarchy, and ruthless despotism hardly credible to any but those who have taken the trouble to step out of their path to judge of things with their own eyes. Koshkeyr is several hundred feet above the river, and the slope to it is covered with numerous carefully cultivated gardens, yielding the finest peaches, grapes, figs, pears, and sultana raisins I ever saw or tasted.

"The town itself contained, four years ago, 260 houses, at present there are only 120, and of this small number 50 had been gutted and burned a few days before my arrival, in a conflict between two local hostile parties, whose chiefs were litigating before the Turkish governor at Sert. The Kurds here belong to a tribe originally Yezid, descendants as they say of the real Sheik Adi, the saint of those extraordinary people."

At the risk of wearying the reader I must give one more extract from Mr. Taylor's paper (*idem*, p. 50) to show of what heterogeneous and unsettled elements the population of these upland valleys is composed.

"All the working and industrious portion of the population of the mountain districts here, and generally throughout Kurdistan, are Armenian and Nestorian Christians, living in a state of serfage, they being the property of the local Kurdish chiefs, who call them their Zeer Kurlees, a term signifying bought with the yellow, meaning gold, as in fact they are bought in the same manner as sheep and cattle."

This account is confirmed in a remarkable manner by Mr. Layard ("Nineveh and its Remains," p. 419) in describing this, the only point at which their routes joined.

"Shattak is a small town rather than a village. It is chiefly inhabited by Armenians, an industrious and hardy race, cultivating the sides of the mountains on which are built their villages, and weaving in considerable quantities, the gay-coloured woollen stuffs so much esteemed by the Kurds. In nearly every house was a loom, and the rattle of the shuttle came from nearly every door. The large and flourishing Armenian communities inhabiting the valleys between lake Van and Jezireh appear to be unknown to modern geographers, and are unnoticed in our best maps.

"The difficulties and dangers of the road have hitherto deterred travellers from entering their mountains. The existence of this people in the heart of Kurdistan might, if taken advantage of by the Porte, be the means of establishing an important trade, and quieting and civilising a country but recently brought under its rule."

Unfortunately for the cause of geography the details of Mr. Taylor's journey from the Mokus district southward across the Djudi Dagh Range to Jezireh have not been communicated to the public.

Route 15. Mr. Layard, on his return journey from Van to Mosul crossed the Achovar Pass into the valley of the Bhotan Su and turned thence directly eastwards into the Hakhiari mountains. The pass itself cannot be better described than in his own words (Layard's "Nineveh and Babylon," abridged edition, p. 219):—

"We had now (12th August) left the lake (Van) and our track led up a deep ravine, which gradually became more narrow as we came nigh to the high mountains that separated it from the unexplored district of Mukus and Bhotan . . . On both sides of the ravine were villages and ruined castles, numerous streams from the mountains irrigated plots of cultivated ground. Ere long we entered a rocky barren tract, patched here and there by fragrant Alpine flowers. After climbing up a steep declivity of loose stones, like the moraine of a Swiss glacier, and dragging our horses with much difficulty after us, we found ourselves amidst eternal snow, over which we toiled for nearly two hours until we reached the crest of the mountains (given by Kiepert as 13,000 feet) and looked down on the valley of Mukus. This is considered one of the highest passes in Kurdistan, and one of the most difficult for beasts of burden . . . The descent was almost more rapid and precipitous than the ascent, and we could scarcely prevent our weary horses from rolling down into the ravine with the loose stones we put in motion at every step." (An eight hours' march).

("Nineveh and its Remains," p. 418). (From Mukus). "The path following the course of the river leads to Sert, Jezireh, and the Assyrian plains. (From Mokus to Jezireh there are five caravan days' journey, and to Sert three, by difficult mountain roads)."

"(Nineveh and Babylon," p. 221.) "The district of Mukus, anciently Mozkh, and one of the provinces of the Armenian kingdom, had only lately been brought under the authority of the Sultan. Like the rest of this part of Kurdistan, it had long maintained its independence under hereditary chiefs, the last of whom, Abdal Bey, after several times defeating the Turkish troops sent against him, was at length captured as he was flying into Persia."

Following up the valley of the Shattak Su tributary, which may be perhaps hereafter recognized as the true Tigris, the route led over two formidable passes, one of which Kiepert gives as 12,000 feet, and over upland valleys of great richness, alternating with ravines deep in snow, where it was wearisome and dangerous to ride, and through which the horses had to be dragged over the rocks; till, crossing the watershed at the Kurdish summer encampment at Billi, his party descended into Zabala Valley at Julmerg.

Route 16. Directly to the north of the above route, and running almost parallel with it, is another mountain track by which Mr. Layard entered the Van district in 1850 from the head-waters of the Zab-Ala, and which he thus describes ("Nineveh and Babylon," p. 199):—

"A dell near our path was pointed out to me as the spot where the unfortunate traveller Schultz was murdered by Mir Ullah Bey, the Kurdish chief of Hakkiari. Turning, up a narrow pass (from the valley of the Zab-Ala) towards the high

mountains, we came suddenly in sight of the castle of Bash-Kaleh (7,818 feet) one of the ancient strongholds of Kurdistan . . .

"Bash-Kaleh was formerly the residence of Mir Ullah Bey. He joined Beder Khan Bey in the great massacre of the Nestorians (1846), and for many years sorely vexed those Christians who were within his rule . . .

"On resuming our journey after a day's rest, we took the direct though difficult track to Van, only open in the middle of summer.

"Following a small stream, we entered a ravine leading into the very heart of the mountains. Three hours' ride, always rapidly ascending along the banks of a rivulet, brought us to a large encampment (of Jews carried away captive in the second century A.D.) . . .

"We had now reached the higher regions of Kurdistan (9,076 feet). Next morning we soon left the narrow flowery vale and the brawling stream, and entered an undulating upland covered with deep snow, considerably more than 10,000 feet above the level of the sea. On all sides of us were towering peaks, and to the west a perfect sea of mountains, including the lofty ranges of Hakkiari and Bhotan. Descending rapidly (from the watershed into the basin of Lake Van) and passing one or two miserable, half deserted Kurdish hamlets, we entered a long narrow ravine, shut in by perpendicular cliffs of sandstone and conglomerate. This outlet of the mountain streams opens into the valley of Mahmoudiyah, in the centre of which rises an isolated rock, crowned with the picturesque castle of Kosh-ab."

Of the two last described routes from the Van district the former presents a succession of such formidable passes and intricate ravines, that it may be almost left out of our consideration as an approach to the Zab-Ala valley; but until further particulars are known of Mr. Taylor's route from the Shattak Su to Jezireh, and in consideration of the large Kurdish and Armenian population, virtually independent of the Porte, in the valleys of the Bhotan Su Tigris, it would be premature to exclude the Achovar pass from the lines of practicable summer communication between Van and the Tigris Valley.

The other route just described through Bash-Kaleh and Kosh-ab, though passing over an upland of 10,000 feet, is the direct summer caravan route between the city of Van and the lower Tigris.

Having brought the reader by these two routes from the Van district into the Zab-Ala Valley, it remains to consider the tracks which lead through the basin of this important tributary to Mosul on the Tigris.

Route 17. Mr. Ainsworth appears to be the only traveller who has given us any description of the course of the river from near its source to Amadiyah. In 1843, in company with Mr. Mitford and Mr. Rassam, he ascended the right bank of the Zab-Ala through that most difficult region, in comparison with which he might well look on the pass of the Ali-Tagh, near Bitlis, as child's play. Of its character the following description ("Travels in Asia Minor," p. 216) of the approach to the Tiyari county may be taken as an example:—

June 15th. "Passing the Tura Duri we gained the crest of the Duralina Hills, the view from the summit of which was truly Alpine. We stood at an elevation of 5,811 feet above the level of the sea, and the valley immediately below us was nearly filled up with snow, upon which in one spot lay a whole grove of trees that had been carried down by an avalanche; but below the valley descended rapidly, till, with one or two villages dispersed in its rugged acclivities, it terminated in a precipice over the deep ravine of the Zab. Beyond these, other vales, each with their tributaries, of many miles of length and width, reached upwards towards the snow-clad summits of the Tura Shina. . . . .

"The descent from the Duralina Mountains was steep and tedious. Accompanied by our Greek servant, I started on foot and gained the last village of vassal Kurds

towards the Tiyari country, and at the foot of a range of hills called here Karasi Tiyari. It appeared from the crest of the mountains to be just beneath us, but it took us a long hour and a half to reach it, half walking, half running. Here we had to wait upwards of an hour before the party had assembled. Mr. Rassam and Davud had attempted to ride down, and had both had falls, by which the interpreter had so hurt his back that we were obliged to have a little longer respite . . . The path, or mule-way, for it was never anything more, took us round the southern slope of the Karasi Tiyari, where its huge shoulder presses down upon the valley of the Zab. This rapid river rolled along amid impracticable precipices, nearly 1,000 feet below us. . . . .

(P. 228.) "At Murah we commenced the ascent of the mountain. The heat of the sun rendered the toil most severe. In one hour's time we reached the foot of the cliffs, the mules working up behind; we then turned along the precipice, near its foot. The road was so bad that we had twice to load and unload the mules; at length we reached a gap in the rocks, which led us to a vast growth of fennel, which announced proximity to the snow line. . . . . On two occasions they had to be unloaded. . . . .

(P. 235.) "We got down the valley of the Itha by means of a glacier, about a mile in length by 300 yards in width. It sloped more gently than the preceding ones; and, although perforated by a mountain torrent, it bore mules and men in safety. By commencing too precipitately, I got into a rate of descent which soon attained a celerity that threatened disastrous results. I endeavoured in vain to bring myself up by thrusting my stick into the snow between my legs, for I was sliding down, from the momentarily increasing velocity I was gaining, with nothing but destruction before me, when I made a last and desperate effort to fix my stick deep enough in the snow to arrest my body, and this time, to my infinite satisfaction, succeeded. When I regained composure, I found myself half a mile from my comrades, near the bottom of the glacier, covered with perspiration and trembling all over."

From this point northwards Mr. Ainsworth found a marked change in the features and scenery of the hills.

"The country towards the head-waters of the Zab (p. 292), beyond this, quite changed its character. There were still a few mountain points with a bold outlying rock, called the Rock of Fire; but the outline of the chains is now tame and rounded, the ranges being neither serrated nor boldly defined, and rising so little above the level of the uplands as to have the appearance rather of hills than mountains."

This may be accepted as the general character of the country which lies along the western side of the watershed separating the Zab-Ala from the basin of Lake Urumiyah, and traversed by Mr. Layard on his journey already mentioned to Lake Van, in company with Mr. Walpole in 1850. (Route 16.) On these upland downs extending from the residence of the Chaldean Bishop at Mar Hananisho on the Persian frontier to the head of the Zab-Ala, herds of horses and cattle belonging to the summer encampments of Kurds were met with; and the natural difficulties had in a great measure disappeared, which he and his party had encountered in the lower valley of the Zab-Ala, both in the earlier part of this expedition to Van, and also in that of 1846, to the Chaldean Christians of the Tiyari district.

His track in 1850 lead from Mosul straight in the direction of the town of Urumiah to Mar Hananisho, while that of 1846 kept much nearer the main stream of the Zab-Ala, though on the opposite side to that taken by Mr. Ainsworth a few years before, till their two routes joined at Julamerick.

Mr. Saudreski ("Journey to Mosul and through Kurdistan to Urumiah." Stuttgart, 1857, by Saudreski), travelling on behalf of

the Church Missionary Society in 1850, followed the same route as Mr. Layard took in that year (though it does not appear that they travelled in company) until he diverged at the village of Neri, taking the track leading direct to the town of Urumiah.

The general character of this part of Kurdistan is described in the following extract:—

"These Kurdistan Highlands present innumerable valleys, gorges, ravines, and mountain passes, very difficult to cross, and capable of being easily defended. They are wedged in between the two rival powers, Turkey and Persia, with Russia leaning heavily on both; and are sparsely peopled by wild Kurdish tribes of Aryan stock, mostly at feud with each other; but ever ready to form temporary alliances for or against either of the foreign states. They have been kept in subjection partly by the exile or imprisonment of their chiefs; but their hearts are filled with hatred of the Turk, for whom their highlands must ever remain a dangerous volcano full of combustible materials. The tribes are only awaiting a favourable opportunity to throw off the Turkish yoke, such as an invasion of Turkey by Persia or Russia."

Elsewhere, however, he describes the tribes as equally hostile to Russia, and they generally felt greatly relieved when assured by the traveller that he was not a Muscovite.

In endeavouring, however, to form a true estimate of these routes, it is only fair to bear in mind that the Kurdish chiefs, who often acted as Mr. Layard's guides during his second journey, seem almost invariably to have accompanied him mounted.

We have, moreover. the significant admission of Mr. Walpole in his description of this journey ("The Ansayrii and further East," by Walpole) that, though racked with fever and so weak as to be incapable of walking, and able only with difficulty and great pain to sit his horse, he was still able to complete his journey to Van with Mr. Layard and his party.

PART II.

No. 17. Ainsworth.	No. 21. Ker Porter.
„ 18. Saudreski.	„ 22. Mignan.
„ 19. Ainsworth.	„ 23. Mr. Rich.
„ 20. Von Thielman.	„ 24. Do.

THE first part of this paper treats of the passes leading through Turkish territory; but any consideration of routes that might be taken by the Russians to the Tigris Valley must be incomplete which omits to take into account the passes leading from Persia into Turkish Kurdistan by the basin of Lake Urumiyah, and through Mount Zagros to Sulimaniah; since the Persian province of Azerbijan, with its capital, Tabreez, lies completely at the mercy of Russia whenever it may suit the latter's convenience either to annex it permanently, or to occupy it temporarily for the purpose of making it a base of operations against Mosul or Baghdad.

The testimony of Bellew, Mounsey, Arnold, and other recent travellers, proves that Persia has been reduced by the late famine and by systematic misgovernment to a state of abject misery; and the

ultimate, or perhaps early, absorption of this province need be regarded as no flight of imagination when we remember that Tabreez was occupied by Marshal Paskiewitch in 1827, and that in his winter campaign he advanced in three columns to the Kaflan Ku range, thus overrunning the whole province. ("Chesney's Russian Campaigns of 1828 and 1829.")

A full appreciation of the critical position of Russia's weaker neighbours may perhaps be most easily obtained by studying Stanford's map of the acquisitions of Russia, showing her conquests from neighbouring states, beginning with that from Sweden of the ground on which St. Petersburg stands in 1721, to her latest acquisition of Kokand, or Ferghana, in 1876.

Let us therefore, for the sake of argument, suppose that to be accomplished which may at any moment be resolved on, and mark the Russian frontier as passing from the head-waters of the Zab-Ala along the present Turco-Persian boundary by the western watershed of Lake Urumiyah, as far as Bistan, and then sweeping round to the north of Senneh towards the Port of Rescht on the Caspian, thus embracing the basin of the Kizil Uzan river together with the towns of Bidjar and Sultaniyah.

This acquisition of territory by Russia would put her in possession of the entrance of all the passes leading from the basin of Lake Urumiyah to the Turko-Kurdish towns of Rewanduz and Sulimaniah; and it would threaten the main trade and pilgrim routes converging on Baghdad through Senneh, Kermanshah, and Zorab.

We need not here contemplate the actual occupation by Russia of Teheran; but the immediate consequence of the loss of Azerbijan by Persia in her next war with Russia would be the removal of the capital to its ancient site at Ispahan, and her virtual withdrawal from the basin of the Caspian to the great plateau of Central Persia.

Assuming, then, Russia to be in occupation of the eastern slopes of the Kurdistan range, as far as Mount Zagros in the south, let us begin with the consideration of the passes leading into the Chaldean, or Nestorian, districts from the east, as we have already treated of those from the north.

Route 17. The most northerly of these, leading from the sources of the Zab-Ala to Dilman at the north-western corner of Lake Urumiah was traversed by Mr. Ainsworth, on 25th June, 1843, and was estimated at about 7,000 feet in elevation. The general character of this upland has been already given on p. 17, and seems to resemble the description by Mr. Layard of that crossed by him a little further south, viz., "low hills rising from fine pasturing valleys with occasional ravines in limestone." The descent into the plain below, smiling with gardens and villages, occupied three long hours to the Chaldean village of Khosran.

The western shores of Lake Urumiyah are not unlikely hereafter to form a base for future operations to the south-west, and are thus described by Mr. Ainsworth ("Travels in Asia Minor," p. 302):—

"The district of Urumiah presents an extraordinary scene to a person accustomed to the treeless monotony of the plains of Mesopotamia. A more fertile district can

scarcely be imagined—one vast extent of groves, orchards, vineyards, gardens, rice-grounds, and villages; sometimes with a village common. It much resembles the best parts of Lombardy, between Milan and Lago Maggiore. All the latter part of our journey was carried for many hours over the same plain of exuberant fertility, clothed with luxuriant verdure; fruitful fields, gardens, and vineyards, irrigated by streams of pure water from the adjacent mountains. The landscape is one of the most lovely in the East; and the effect is not a little heightened by the contrast of such surprising fertility with the stern aspect of the surrounding heights, on which not a solitary tree is to be seen; while in the plain, the willows, poplars, and sycamores by the water courses; the peach, apricot, pear, plum, cherry, quince, apple, and vine in the orchards, impart to large sections the appearance of a rich variegated forest."

Following to the south we find the pass leading over the Persian frontier direct to Urumiyah, from the village of Neri, where we have seen above that Mr. Saudreski left Mr Layard's route from Mosul. The following is a summary of his narrative ("Journey to Mosul and through Kurdistan to Urumiyah," Saudreski):—

Route 18. Passing the spurs of the Shiah Resh (Black Mountain) he reached the true watershed of this region at a point above the village of Neri. This village is perched on a well-wooded height, growing fine walnut-trees, poplars, &c., and commanding a prospect of the snowfields on the eastern slopes of the Jebel Sati. Beyond Neri a steep and very zigzag path, scarcely more than two feet wide, leads down through a mountain pass and countless windings to a wild and very deep valley. Four hours were consumed in traversing the pass, which brought him to the Nestorian village of Holaneh. Beyond this place is the pass leading southwards to Persia, but trending east by north the route now lay across a bleak ridge destitute of vegetation, 6,000 feet above the level of the sea. The hills themselves about Holaneh attain an altitude of at least 8,000 or 9,000 feet, and are covered with snow even on their southern slopes. Here another pass, an hour long, leads to a wide, verdant valley, encircled by hills on all sides, except towards the north, where it is more open.

The road crossing it, still to the north-east, passes several streams fed by the melting snows, and all falling into a little river winding through the centre of the valley. These streams belong to the water system of Lake Urumiyah and flow through the marshy, but on the whole well-cultivated, plain of Mergovan. Another gloomy pass is now traversed, enclosed by bare, craggy hills, and after countless windings gradually widening towards the north-east, where the hills begin to fall off, and the country becomes more inhabited and better cultivated, the pass leads directly into the plain of Lake Urumiyah, of which it affords a fine prospect, with its gardens, groves, and the glassy surface of its brackish waters, and the hills rising in the distant background beyond it.

I have deemed this route worthy of close attention, in spite of the natural obstacles which it presents, because it offers the most direct communication between Urumiyah and Mosul, while avoiding the still more difficult districts of Hakhiari and Tiyari to the north, mentioned before as visited by Layard and Ainsworth, and that of Rewanduz to the south.

Route 19. Mr. Ainsworth ("Ainsworth's Travels in Asia Minor," p. 309), returned to Mosul by the pass of Keli-Shin, which leads direct from the Persian town of Ushnei to Rewanduz, over the Shiek Iwa Mountain, commonly called the Peak of Rewanduz—a three days' journey.

After noticing another track, or great ancient road, direct from

Ushnei, past an ancient monument and across the Keli-Shin * he thus describes the formidable difficulties which he encountered:—

(P. 310.) *2nd July.* "We started at an early hour for the ascent of the Keli-Shin, which was performed on foot. . . . . We then proceeded on our journey, and, crossing the first range, gained a country with less snow and more wood, and with many flocks of sheep and goats feeding on the mountain sides. We soon, however, came to another range with glaciers, the slope of which created some anxiety. We passed three of these, however, in safety; it was more fearful to look at another passing over them than to venture oneself; a single slip would infallibly have hurried a person to eternity . . . . We now continued our ascent of the mountain. Vast piles of snow, accumulated by the drift winds to a depth of many hundred feet, were only broken through by bold and sharp rocky pinnacles of grey and green quartz, or broken off abruptly over dark precipices of brown or blue schists . . .

(P. 311.) "Proceeding over the first mountain we had a descent to make through a ravine filled with snow, then another ascent, steep and rocky, and another glacier, till hope deferred made the heart sick. At length we came to a precipice formed by a vast dyke of sienites, which crossed the whole crest, and constituted the peak of Rowandiz, or Sheik Iwa, as it is called by the Kurds. . . .

"The elevation of Rowandiz by boiling point thermometer we found to be 10,568 feet. . . .

(P. 314.) "After half running, half sliding, we found ourselves in an hour comfortably seated just below the inferior limits of snow, where a fire had been kindled and breakfast was prepared to reward us for our toil. . . .

"A large caravan passed along the road in the course of the morning; and indeed, notwithstanding the predatory habits of the Kurds, this is in summer-time one of the most frequented passes in this part of the country, the same merchants having recourse in severer seasons to the road by Rowandiz to So-uk-bulak. But in winter all roads are equally impassable.

(P. 315.) "The elevation of our halting place was 8,568 feet. . . . It took us four long hours' ride to descend from our station to the head of the valley of Sidaka or Sidek. . . . Although the present castle is a comparatively modern building, the rock on which it stands appears to have been chiselled at a very remote date. . . .

"There is every reason to believe from the peculiarity of its position, as well as from its antique appearance, that it was a station or fort at the time when this was the great road from Nineveh to Ecbatana. . . . .

(P. 318). "It took us five hours to accomplish a distance of 18 miles, which led us nearly round one-half of the mountain's circumference. We then began to descend towards the vale of Rowandiz, by a difficult pathway, carried over a shelving declivity of schists, and on which we were obliged to walk. It constitutes the second of the difficulties of this road, which are three in number, viz., the snows on the pass of Keli-Shin, the descent on slates at the foot of Ser-i-bund, and the vast limestone precipices west of Rowandiz. . . . .

(P. 324.) "Passing the gardens of the town (Rowandiz), we made a descent into a deep valley with a gap through the lime ridge into the bed of the Rowandiz River; we then ascended one hour and a half to the crest of the shoulder of Sir Hussan Beg. We descended from hence one of the most remarkable precipices I have ever seen a road carried down. It was not so lofty as many in the Tiyari; but it was nearly vertical, and upwards of 800 feet in perpendicular depth, and yet the road was hewn in the face of this precipice, along which it wound round and round, with so gradual a descent that it might be effected safely on horseback. We went fast, for we were thirsty, and the windings must have been six or seven miles in length."

Sir Henry Rawlinson ("Journal of Geographical Society" vol. x, p. 20), visited the ancient inscribed pillar Keli-Shin (blue pillar), alluded to by Mr. Ainsworth above, and which gives its name to the pass, on the 27th October, 1838.

[1] Described below by Sir H. Rawlinson.

"This morning accordingly. when the weather fortunately cleared, and the wind, which had been blowing furiously for the two preceding days, appeared to have exhausted itself, I set out, attended by two horsemen, well mounted, well wrapped up, and with every defence against the snow drift, which I was told I should certainly encounter at the summit. For five miles I wound slowly up the face of the mountain, pursuing a broad open track, neither steep nor difficult, along the slope of a huge shoulder which juts out from the great range. At this point I entered the snow, and the difficulties commenced; the ravines which indented the face of the shoulder became, as we ascended higher, choked with snow, and in one of them we narrowly escaped being engulfed. At length however, alternately riding and walking, as the nature of the ground admitted, we gained a more open part of the mountain; and then, pushing rapidly on, gained the summit of the pass, exactly in four hours from leaving the fortress at its foot. The distance I should judge to be about 10 miles. I here found, upon a little eminence by the side of the road, the famous Keli-Shin, the stories of which had long excited my curiosity . . .

"At the distance of five hours from the pass (p. 22) which I ascended, there is a precisely similar pillar, denominated also Keli-Shin, on the summit of the second range which overlooks the town and district of Sidek . . . But the chief value which I attach at present to these two ancient relics of antiquity is the determination which they afford of a great line of communication existing in ancient days across this range of mountains. This line could only have been to connect two great capitals, and these capitals must then have been necessarily Nineveh and Ecbatana . . .

"During the troubles of modern times (p. 23) the track has been closed against the transit of merchandise, but Ali Pasha, in his late attack upon this country, found it practicable for artillery a long way beyond Herir, and on the Persian side it is known to be open to guns, almost to the very fort of Rowanduz. I learned from the Kurds that the only really difficult part is between Rowanduz and Herir.

Although Sir Henry Rawlinson does not speak of the latter part of this route from personal experience, his opinion on the military routes of Kurdistan is entitled to the greatest respect, as he long held a high position in the Persian service, and traversed this range in various directions in command of a mixed force, accompanied by field-guns.

Route 20. Next in order comes the Souk-Bulak route, alluded to above by Mr. Ainsworth as being easier than that of Kali-Shin just described.

This road was taken by Baron Thielman, the well-known German diplomate, a few years ago, and is named the Garuschin Pass. It is thus described by him ("Thielman's Caucasus, Persia, and Turkey," vol. ii, p. 88):—

"A choice of two routes exists to get from Souk-Bulak to Mosul, by way of Rewanduz. The northern route leads through the district of Sulduz, south-west of Lake Urumiyah, to Ushni (called also Ushnin), and thence crossing the pass of Kallischin, said to be 1,000 feet in height . . . then traversing the valley of Sidakatschai to Rewanduz"[1]

Of the southern route which he followed, Baron v. Thielman writes:

"Mahmoud (the guide) called it (the present route) the pass of Garuschin, and described the route as easy and comfortable.

(P. 91.) "Our road led (at first) up the valley of the river of Souk-Bulak, and then ascended the barren and totally uninhabited mountains on the left bank. We now rode for hours through desolate mountain regions without either variety or view. . . It was late in the afternoon when we reached the watershed of the little Zab at an altitude of 6,180 feet, and from here we had a beautiful parting glance at the lake (Urumiyah) and snow-crowned Sahend mountains . . . The district Ladishan,

[1] That last described by Ainsworth.

inhabited by the tribe of Balbas Kurds, and watered by the little Zab, lies at an elevation of 5,650 feet, and our descent from the watershed to the fortress of Paschy was a very rapid one. Kiepert's map shows a shorter route, but across a higher pass, leading thither from Souk-Bulak, by way of Legwin. Paschy (which the Russian map gives as Passoa, whilst Kiepert gives it Pisan or Peshwa) seemed, viewed from a distance, to possess a very defiant-looking castle. But all magnificence of aspect vanished on approaching the spot, and there only remained a crumbling wall, encircling a large open space, and protecting the little house of the Khan.

(P. 94.) "According to the description (*vide* Butler's Geo. vol. ix, p. 599) of a former traveller, who had crossed the Zagros chain to the south of the ravine, through which the little Zab flows, we now looked forward to a most difficult mountain passage. To our great surprise we reached the Turkish frontier after an hour's ascent of a steep but not otherwise arduous path, leading across a ridge some 1,200 feet in height above the valley. The actual watershed lay lower down . . . After several hours' ride through a grand but yet lovely valley, we reached Rajat, the Turkish frontier village . . .

(P. 96.) "To-day's journey conducted us through the most romantic scenery which I saw between the Caspian and the Mediterranean. The valley of the Rewanduztschai abounded in beautiful views. At one time lofty snow mountains pierced through side ravines of wild grandeur, then the valley widened into small recesses, in which nestled pleasant villages with rich gardens, half concealed beneath the shade of planes and elms, and encircled by neatly tilled fields; the oaks are of more than twenty different kinds . . .

(P. 97.) "We inferred that the lofty snow-capped cone visible through the side valley on our right, and which was not unlike the Matterhorn, must be the Sheik Iwa, the northern side of which is crossed by the pass of Killischin . . . The road was good, and the bridges over the roaring Rewanduztschai, which we had several times to cross, were in fair condition, the last bridge merely consisted of two stems of trees resting on one pillar, but our horses stepped along it without the least hesitation.

(P. 98.) "The next morning a steep and tortuous path brought us to one of the heights which enclose the hollow of Dergala, and thence down into the valley of an affluent of the Rewanduztschai. The latter descent over a path scarcely a foot wide, covered with loose stones and bordered by a precipice, was the only hazardous passage during the whole journey fron Tabreez to Mosul; in rainy weather it must be quite impracticable. We prudently dismounted and left our horses to find their own way down. They picked their way very quietly and sagaciously down the narrow path . . .

(P. 99.) "The valley was enlivened by large flocks of sheep and goats which, driven by curiosity, ran after us. Shortly afterwards we reached the main valley and continued along it, till we arrived at the town of Rewanduz.

"We left the town (p. 104) by the elevated southern extremity, and at first descended into a very peculiar oval-shaped hollow of the rocks, which communicates with the valley, or rather the ravine of Rewanduz, by a perpendicular crevice only a few feet broad.[1] A steep and stony path led out of the hollow to the left bank of the Rewanduztschai . . .

"A narrow but tolerably good foot-path brought us down to the ravine; but this is the only means of communication between the district of Rewanduz and the outer world."

The next group of passes which claim our attention are those leading from Persian territory through the Zagros range, and converging on Sulimaniyah, an important Turkish frontier town, from which numerous roads diverge to Mosul and Baghdad.

Sulimaniyah has, like Amadiya and Rowanduz, been reduced, during the present century, from an independent Kurdish district under its hereditary feudal chieftain, to a tributary Pachalik of the province of Baghdad.

1 *See* Ainsworth's description of his descent by an ancient road on the face of the cliff.

Route 21. The most westerly of these passes was taken by Sir James Ker Porter ("Travels in Georgia, Persia Armenia, &c.") on his return journey to Souk-Bulak in December, 1822.

Leaving Sulimaniyah on 12th December, just as the winter was setting in, he started on his adventurous journey, After two days to Marut, the serious difficulties began in surmounting the spur which separates the Kyzylchy Chai from the Banna Rud River—

The following is his description of the two days' march from Mosnair over the Daroo Mountain (p. 463) :—

"Words cannot paint the difficulties of this pass. The road over which we clambered was actually over naked and slippery marble rocks . . . . Every mountain I had hitherto crossed, through the whole range of Caucasus was security and ease of travelling compared with the actual dangers of this. One slip of man or beast was destruction; yet to my unceasing astonishment, notwithstanding the nature of these obstacles, even our laden mules made their way with an ease and sure-footedness which seemed miraculous.

(p. 473) "December 16th. From Baytoosh over Daroopeak. Had I been aloft in a balloon, I could hardly have felt more abandoned to the great gulf of air above the clouds; all around was so steep and bottomless . . . .

"We cautiously followed each other over these points of particular danger, but most of the Kurds undauntedly kept their saddles, passing over our fearful impediments with a firmness and lightness which could not fail reassuring our resolution."

The gathering snow storms which threatened to break over the travellers, and might have caused their destruction in the mountains, fortunately held off till they gained the plains of Persia.

Route 22. We have now to notice an adventure more daring even than the last, of which Mount Zagros, a little further east, was the scene. Captain (afterwards Major-General) Mignan, of the Indian army, returning to India in 1839, travelled across Russia with his wife, two children, and an English maid. After narrowly escaping being lost in a snow storm in the Vladikaukas Pass in December, which destroyed a large Russian detachment, they pushed on through Tabreez, down the eastern side of Lake Urumiyah, past Bogaun (Burchan) to Miraady (Miradeh). Thence by Banna and Beestan to the capital Sulimaniyah (where he arrived early in April) by the only pass open in winter, his family accompanying him in mule panniers.

He thus describes ("Winter Tour into Kurdistan," by Captain Mignan, p 277) the passage of Mount Zagros, which he found far more difficult than any part of the Dariel (or Vladikaukas) Pass :—

"We started soon after daybreak to cross Zagros and proceed to the capital of the kingdom. The morning was unusually sultry, and during our journey a dreadful storm of rain, hail, and sleet, accompanied by violent gusts of wind, thunder and lightning, broke upon us. We were soon enveloped in a thick fog which reminded me of the situation of the 10,000 Greeks under Zenophon during their ever-memorable retreat over these very mountains. They were hidden from the enemy by a mist similar in density to the one which we now experienced; for we could not see the road-side although we were only two yards distant . . . . The road was so slippery as to render the utmost caution necessary, as all around was Stygian darkness . . . . Having reached an immense height, the clouds suddenly swept away, and a vast extent of mountain ravine and glen lay exposed to our glance, but they were again as quickly obscured by the passing clouds."

Three separate ranges had to be crossed before reaching

Sulimaniyah, the capital of the kingdom, each pass occupying a whole day, the second of which was enlivened by an encounter with the armed mountaineers, who barred the way and resisted his servants. Captain Mignan only forced a passage pistol in hand.

It is worth while to notice here in passing, the effect of a more southern climate in reducing the close season in these mountains to about four months, whereas in the neighbourhood of Lake Van it would probably be extended at least a month longer both in autumn and spring.

It only remains now to notice the journeys of Mr. Rich, our Consul at Baghdad in the early part of this century, who travelled in search of health through Sulimaniyah to Senneh in Persia, accompanied by Mrs. Rich and a retinue of Baghdad and Indian servants, during the summer of 1820.

Route 23. His party being worn out by fever in the hot valley of Sulimaniyah, he started, on 17th July, over the Giozheh Pass, as being the easiest by which to cross the chain, or rather wall, of bare hills which bounds Sulimaniyah on the east. ("Rich's Residence in Koordistan and Nineveh," p. 159.)

"We reached the foot of the hills by a gentle rise all the way up from Sulimania a little after 4 A.M., and immediately began the ascent, first in the dry bed of a torrent, and then along the steep face of the hill, by a very narrow and precipitous path . . . It (the baggage) had had a difficult passage over Giozheh, and two or three of the baggage mules got a roll down, but fortunately no serious accident occurred.

(P. 162.) "As we had been told at Sulimania that the roads over which we were to pass were very steep, rough, and precipitous, and in some places in the mountains so narrow that two horses could not go abreast, we were obliged to abandon the Takht-revan (mule litter) and mohaffas on this excursion, leaving them behind us at Sulimania. The women servants were sent off on horseback last night with the tents and baggage. Mrs. Rich accompanied us on her pony, a present from Osman Bey, which carried her over the mountains admirably . . .

(P. 166.) "From the banks of the Tenguzhee, we rose immediately by a very steep ascent, which occupied thirty minutes, at a good hard pull . . . We found the road to-day excellent, and much better than I had seen in any part of Asia Minor. Some of the views down into the valley reminded me of the Jura . . .

(From Doladreigh.) (P. 188.) "We soon began a very steep ascent, I think the highest and steepest I had yet seen, but the road was excellent. We attained the summit at six, the ascent having occupied about forty minutes, for half an hour of which it seemed, as we toiled up, to be almost perpendicular . . . We immediately began to descend by a beautiful and excellent road, among a thick forest of oaks, through which it ran in a zig-zag direction, and was not so steep as the ascent . . . Penjineen is the emporium of the wandering tribes.

(P. 184.) "Caravans go from hence to Hamadan in eight days, to Sinna in four . . . There are some families of Jews here, who trade in gall nuts, hides, &c. with Sinna and Hamadan. Many hides are exported to the latter place. The village Jews of Koordistan are also dyers . . .

(P. 191. From Gueizawera). "We were off at 5 A.M., and proceeded through a hilly but open country till six, when we came to the entrance of a narrow valley, formed by two stupendous cliffs, which reared their bare heads above the oak woods that cover their declivities. The small river of Aserabad, or Gurran, flows through the pass, and is crossed by a neat bridge of three arches . . . the road extremely beautiful, through woods of oak, ash, wild pear, vine and tchinar, or oriental plane, which cover the hills almost to their summits, and among them we noticed hawthorn and gigantic wild rose. It was enlivened by a large division of the Jafs, proceeding to the plains of Zeribar, with their families and flocks. Their property was loaded on bullocks . . .

(P. 192). "The road was excellent, the vale through which we ascended very narrow. At ten minutes before eight we came to the foot of a very steep ascent in the same direction, the road not winding much; at a slow progress it occupied us forty-five minutes in ascending. The mountains were gypsous and slaty. At 8.30 we reached the top of the Col, and saw higher summits on either hand quite bare. We almost immediately began descending by a steep path, the wood becoming more rare, and was confined to the dwarf oak . . . At five minutes past nine we reached the foot of the pass. This pass of Zagros is called Garran, the name of a peer, or saint, as I am informed, though it is certainly no Mahometan name. The pass of Ardbaba to Bauna is reckoned easier."[1]

I have given extracts from this itinerary at considerable length, to show the importance of this route, the chief and easiest communication between Sulimaniyah and Senneh, from which roads diverge to all parts of Persia, including Rescht, Teheran, Kermanshah, and Ispahan.

The last route which we have to notice is that by which Mr. Rich returned to Sulimaniyah from Senneh. Leaving the plateau on which he crossed the head-waters of the Kysyl Uzen River he entered the mountains at Kara-Bokra. At Banna he crossed the route taken by Captain Mignan, then, following the Banna Rud River as far as Merwa, he turned due south to Sulimaniyah.

After stating that "from Kara-Bokra to Serkhuan-i-Shelal, the capital of Teratul, is four hours, thence to Beestan four hours," he thus describes his road from Kara-Bokra:—

(P. 233.) "At five minutes past seven we began to descend by a good road. Upon reaching the bottom we found ourselves in a narrow, rocky valley, or rather ravine, among the hills, in which we continued the rest of the day, to our infinite trouble. The road continually ascended and descended along the steep sides of crumbling slate. The path was narrow and shelving; indeed it was nothing more than a sheep-path, with a precipice on the left hand. The Koords even confessed it was the most disagreeable road they had ever travelled over, and, for the first time, at a bad pass, I saw them dismount. Omar Aga's horse fell with him once, on the very edge of the precipice; he very adroitly threw himself off at the moment without quitting the bridle, otherwise horse and man must have been killed. My head turned so much that I was obliged to walk the whole way from the foot of the mountain to the end of the march . . . .

(P. 234.) "From the mountain we saw Mount Kelli Khan, and Mount Zagros, or a part of it. We reached the foot of the mountain at 7.35 A.M.; and soon after came to a miserable little village named Hajee Mahommed. Thence, rising a little, we dropped at once on the village of Soota, by a most horrible break-neck descent, with a precipice on our left hand.

(P. 335.) "At 2 P.M. we mounted, I may say marched, for I did not take to my horse the whole way on account of the precipices, which were too much for my weak head.

(P. 239.) (From Meek.) "At 11.45, without having ascended considerably, we reached the top of a very steep descent, I think the steepest we had yet met with; it occupied half an hour, and is called Kelleh Balin. Both Omar Aga and Abdullah Bey agreed in saying it was a pass of Zagros."

From this pass the road presented few difficulties of a serious nature, until within a few miles of Sulimania, where a part of the track over Mount Azmir was found out of repair, and a party passed over on foot, leaving their horses to follow alone. The general nature of the Sulimania district, after turning south from Merwa, formed a striking contrast to the inhospitable mountains of Persia. All along the route innumerable springs gushed from the mountains, which were clothed

[1] Described above by Captain Mignan as very difficult.

with forests of oak, while the villages, surrounded with walnut-trees, gardens, and vineyards, made up a scene at once grand and beautiful.

With regard to this last group of passes leading to Sulimania, it will be observed that three out of the four have been crossed by English ladies, and we may therefore infer that they would not be found impassable by mountain artillery. And in endeavouring to form a just estimate of the difficulties described by travellers, we should not fail to remember that the impression left on the mind by mountain gorges, precipices, and glaciers, more especially if approached direct from the plains, depends to a great extent on the state of the observer's health and nerves, as affected by such climates as those of Mesopotamia and Assyria.

Where we hear of caravans of laden mules and cattle passing, and of the natives making their journeys on horseback, it may be presumed that a well equipped mountain column could follow.

And here the survey of the passes of Kurdistan may be fitly brought to a close, as the great trade and caravan routes converging on Bagdhad from the plains of Persia, through Kermanshah and Zohab, are too well known to require special notice.

In this region the mountain barrier sinks nearly to the level of the great plateau of Persia, 5,000 feet in elevation, offering no obstacle to a descent into the plain of Baghdad.

Nor does it come within the scope of this article to discuss so vital a question of Imperial policy as where, or how, the defence of Baghdad may be conducted, should the command of the Persian Gulf be hereafter threatened.

Let us, therefore, turn to the consideration of the physical and moral influences which might be found to favour a Russian descent on the Tigris Valley.

There is first the important fact that the level of Lake Van is upwards of 5,000 feet, and that of Lake Urumiyah 4,000 feet, above the sea; while the following are the elevations of the principal towns from which an immediate advance would probably be made upon the passes.

Erzingan	4,200 feet.
Mush	4,200 ,,
Bitlis	5,100 ,,
Ushnu..	4,900 ,,
Souk Bulak	4,400 ,,
Sakkyz	5,300 ,,
Senneh	5,800 ,,

Thus, as a rule, the greater half of the ascent would be already gained, leaving from 3,000 to 5,000 feet to be surmounted.

The climate, too, may be considered an important ally of the invaders, who might choose for the beginning of their operations those months of the summer when the northern valleys would be bearable, if not actually pleasant; while the bulk of the defenders would be exposed to oppressive heat, at elevations of 2,000 or 3,000 feet on the southern

slopes; or the actual passage might be deferred till the climate of the lower plains becomes suitable for operations in the autumn.

Nor need the question of supplies present insuperable difficulties, if the sympathy of a portion of the population were secured; for it has been computed by Major Millingan that the Kurdistan Range supports no less than (40,000,000) forty millions of sheep, from which Damascus, Baghdad, and the other cities of the plains derive their supplies. The valleys we know to be of great richness and often well cultivated.

No advance would of course be attempted by Russia until she had time to organize her communications with the above entrepôts—by means of serviceable roads—from Georgia through Erzeroum and Tabreez, and from the Caspian by Rescht.

But Russia might hope to find her most powerful ally in the anarchy prevailing among the various races and creeds, and the bitter hostility entertained alike by Kurdish clans, Kissilbash or Yezedi pagan tribes, and by Chaldean and Armenian Christians, towards the Osmanli Turks, who are regarded by one and all as foreign oppressors.

The works which have been quoted above show that, along the whole range, the independent tribes have been only brought under the authority of the Ottoman Government during the present century, and in many cases during the last thirty years; and that this has been effected by the usual agency of fomenting the jealousies of neighbouring sects and by inciting them to mutual extermination.

Mr. Taylor has told us of the Kissilbash tribes maintaining their independence in the fastnesses of the Deyrism Dagh and of the Kurds on the Dibeneh Su; while both he and Mr. Layard notice the numerous and industrious Armenian population ground down by the oppression of their Kurdish masters in the remote valleys south of Lake Van. Both Mr. Layard and Mr. Rich seem to have interested themselves in the condition of the Yezedies, scattered through the districts of Saert and Mosul—a sect who have survived the systematic barbarities to which they have been subjected through the detestation in which their peculiar heresy is held by Kurd and Turk alike.

Russia has taken advantage of these persecutions to offer the Yezedi fugitives an asylum on the northern slopes of Mount Ararat, where they guard the frontier against the incursions of the Kurds, and she has thus secured to herself allies far within the Turkish frontier.

It is sad to contemplate the change in the condition of the Chaldean Christians of the Zab-Ala Valley, since 1843. Mr. Rich speaks of them in 1820 as a formidable independent tribe holding the neighbouring Kurds in awe; and Mr. Ainsworth had proof of their martial spirit in 1843, while the first massacre was hourly expected.

For the account of the massacre of 1846, by Beder Khan Bey of Rewanduz, I would refer my readers to "Nineveh and its Remains" (vol. ii, Chapter VII), which brings forcibly to mind the spring of 1876, when the Balkan Valleys were the scene of similar outrages. The deplorable state of the district is also forcibly described by Mr. Layard, ("Nineveh and Babylon" abridged edition, pp. 232—236,) after revisiting the tribes in 1850. And this, be it remembered, is no highly

coloured picture drawn by a Russophile partisan in the heat of controversy, but the dispassionate narrative of a distinguished diplomatist whose knowledge of Asiatic Turkey is probably unequalled by that of any living Englishman.

The total population of the independent Chaldean Tribes, in 1830, was given on the authority of their Patriarch ("Missionary Researches in Armenia," Messrs. Smith and Dwight, p. 294), at 70,000 souls; but this was held by the English Consul at Tabreez at the time to be an under-estimate. Their present numbers have been given by recent authority at 100,000.[1]

These primitive Christians do not appear to extend to the east of the Rewanduz district; but we have ample testimony from Mr. Rich of the disaffection which was openly expressed by the Kurdish feudal chiefs round Sulimaniyah towards the Turkish Government during his sojurn among them in 1820.

Captain Mignan, however, found the district of Sulimaniyah practically independent nineteen years later; for writing in 1839 ("Winter Tour into Kurdistan," Mignan, p. 285) he says:—

"The government of Sulimaniyah is administered by a Pasha who is by birth a Kurd, subject to neither Turk nor Persian. To please the Russians he has occasionally sent a present in cash to the Prince Royal of Persia; and Marshal Paskiewitch is desirous of taking him under his especial protection that, in case of need, he may be induced to furnish cavalry to harass, by their repeated incursions, the inhabitants of those countries by which they are bounded. For such duty they are eminently fitted. A Kurdish chief assured Fraser that if 1,000 Europeans, of any nation, made their appearance amongst them, 20,000 Kurds would immediately rise and join them."

It may thus be said that the sound of Marshal Paskiewitch's victorious columns, advancing through Azerbyan, penetrated the fastnesses of Mount Zagros and found an echo 200 miles off, beyond the Turkish frontier.

Mr. Fraser ("Historical and Descriptive Account of Persia," by Fraser), in 1834, in his journey from Souk-Boulak to Sulimaniyah, seems to have followed almost the same route as that taken by Sir James Kerr Porter, twelve years before, *viâ* Seradust. But he found the Pashalic in the occupation of the Persians, who had recently overrun and almost depopulated it. At Seradust alone 1,000 of the inhabitants had perished from cold and famine, and it has probably never recovered the prosperity which it enjoyed at the time of Mr. Rich's visit.

History would seem to teach us that the true value of an extensive mountain range, as a barrier to invasion, rests chiefly on the measures which the defenders can adopt to strengthen it by their own military resources, or by the active co-operation of the inhabitants.

What resources Turkey may hereafter command on this part of her Asiatic frontier, it is not our province here to discuss, but we see from the concurrent testimony of all the travellers who have had the means of forming an opinion, that Russia, once in possession of the northern outlets of the mountains, would find ample materials ready

[1] Sir G. Campbell.

to her hand for alliances and intrigues among the actually, or till recently, independent tribes along the whole length of the chain.

Nor must we lose sight of the fact, an instance of which we have seen in the long-concealed highway through Deyrism Dagh, that the exactions of such a government as Turkey may make it the interest of the mountain tribes to oppose, rather than to facilitate, the opening of their passes. We have therefore probably no right to assume that, because only certain practicable roads are known to the provincial authorities, there may not be others equally practicable and perhaps equally numerous, which they have either never heard of, or never dared to explore, but which would be disclosed to an invader commanding the sympathies of the inhabitants.

It is obvious that, for many years after reaching the frontier indicated, it would be neither in the interest nor the power of Russia to attempt a descent on the plains of the Tigris; but it would be only in accordance with her practice in Asia to endeavour, under pretext of encouraging trade, to improve the tracks on her side of the passes, and to send forward agents to establish friendly intercourse with, and eventually a protectorate over, her neighbours on the southern side.

Separate or simultaneous encroachments might then be pushed forward upon such important strategical points as Masgerd, Palu, and Husru, threatening Diarbekr; Saert and Julamerg, east and west of Mosul; or upon Rewanduz and Sulimaniyah towards Baghdad.

Once in possession of these intermediate places Russia might wait her leisure to improve the roads and to profit by the necessities of Turkey before venturing on more important acquisitions.

16*th January*, 1878.

CANADA.

DOMINION ARTILLERY ASSOCIATION.

PRIZE ESSAY.[1]

ON THE SUPPLY, CARE, AND REPAIR OF ARTILLERY-MATERIAL, INCLUDING SMALL ARMS AND AMMUNITION FOR CANADIAN MILITIA.

By Captain and Brevet Lieutenant-Colonel C. E. MONTIZAMBERT, "B" Battery, Canadian Artillery, School of Gunnery, Quebec.

Extract from General Orders, 23rd March, 1877.

DOMINION ARTILLERY ASSOCIATION.

MEDAL FOR ESSAY.

His Excellency the Earl of Dufferin, K.P., &c., Governor-General of Canada, has been graciously pleased to express his intention of offering a medal for the best essay on the supply, care, and repair of artillery-material, including small arms and ammunition for Canadian Militia, to be competed for by Officers of the Canadian Militia Artillery, being members of, or belonging to, corps affiliated with the Dominion Artillery Association. Officers or others who have served in the Royal or Royal Marine Artillery to be excluded from competition.

The essays to be distinguished only by a motto, not that of any Artillery corps, and the manuscript not to be in the handwriting of the competitors.

The essays to be sent to the President of Council, Dominion Artillery Association, Quebec, before the last day of July, 1877.

The judges to be Officers of the Royal Artillery, viz.:

The Inspectors of Artillery and the Professor of Artillery, Military College, Kingston.

The essays may be in English or French; subject matter will be considered of more importance than style. Quotations and extracts from works bearing on the subject may be freely made use of, but the names of the authors so quoted must be given in foot or marginal note.

The best essay will be printed at the expense of the Dominion Artillery Association, and distributed to members.

"Potz blitz! Das ist ya von Gustle aus Blaserwitz!"—*Schiller.*

On the withdrawal from the Canadian Dominion of the Imperial Legions in the fall of 1871, a transfer was made of a considerable amount of warlike stores and material from the British to the Canadian Government, of which the late Sir George Cartier was then

[1] Reprinted at the suggestion of the President of the Association.

Premier and Minister of Militia and Defence; Lt.-Col. Robertson Ross (late 25th King's Own Borderers), being Adjt.-General, and Col. Powell, Dep.-Adjt.-General of Militia, Lt.-Col. Wily, Dom. Mil. Storekeeper, took over the material transferred, and was assisted by Lt.-Col. French, R.A., C.M.G., then Lt. French, R.A., and Firemaster of the R.A. Brigade, then stationed at Quebec), in matters connected with the Artillery branch.

After the march out from the Citadel of Quebec of three batteries of the 3rd Brigade Royal Artillery, three companies Royal Engineers, and the 1st Battalion 60th Royal Rifles, under Col. Gordon, the last British troops quartered in the Canadas, the keys of the strong old Keep were handed over by General Hamilton, R.E., Commandant, to Lt.-Col. Strange, R.A., who, with an incipient battery of Canadian gunners, undertook the important duties of the garrison of Quebec, and has ever since kept flying over the Citadel that glorious flag the Union Jack, which for so many years has, without interruption, floated proudly on the grand old fortress.

Portions of the then existing armaments at the military posts, St. John, Quebec, Montreal, Kingston, and Toronto, came to us as a free gift, and the roll-books, imposing enough as far as the number of pieces of ordnance is concerned.

We took over at St. John, N.B.	26	pieces.
,, ,, Quebec	187	,,
,, ,, Montreal	33	,,
,, ,, Kingston	85	,,
,, ,, Toronto	9	,,
	340	in all.

With the exception, however, of ten 7″ Armstrong B.L.R. guns at Quebec, these consisted of old S.B. cast iron pieces, guns, carronades, howitzers, and mortars.

Garrison Artillery.

The guns, 68, 56, 32, and 24 prs., are of little use where now mounted, and are to be replaced in the principal fortresses by more modern weapons; those S.B. guns would be useful for the armament of gunboats on the lakes, nothing much heavier being likely to be brought against them on those inland waters.

Predominance on the upper lakes, especially on Lake Ontario, is of the first importance. On this subject, Col. Fletcher, Scots Fusilier Guards, late Military Secretary to his Excellency the Governor-General, says in a very able lecture on Canadian Defence:—

"*Coûte qui coûte*, the command of Lake Ontario must be secured "and maintained, ... and, above all, Kingston would have "to be placed beyond the possibility of capture."

Of the 68-prs. there are two mounted in coast batteries at St. John, N.B.

The 56-pr. class is represented by one gun in Fort Henry, at Kingston, where it would doubtless give a good account of anything

likely to be brought against it; not so with the heavier 68-prs. at St. John, that port being open to the attack of armoured cruizers.

The carronades and howitzers, firing charges of case and grape, would answer very well for the flank defence of ditches and curtains, and those in artillery charge are, most of them at present, mounted in positions for that purpose. In more modern armaments the caponnières would be armed with Gatlings, probably of a calibre sufficiently large (say 65) to allow of the bullets breaking scaling-ladders.[1]

The mortars given over were 13″, 10″, and 8″, land and sea service.

There are also 12 and 18 pr. siege guns, one battery of the latter, with carriages and waggons complete, at Quebec, and another at Montreal.

Formerly, the Royal Artillery had 40-pr. wedge Armstrong R. siege guns; these are about the same weight as the old 18-pr. S.B., and are, of course, an infinitely superior arm for the purpose for which they are intended; none of them, however, were left in the country on Dominion charge.

Of the ten 7″ B.L.R. ordnance, four are mounted *en barbette* on the salient bastions of the Citadel of Quebec: three with their stores, carriages, platforms, and racers, are lying, one in each of the splendid forts at Point Levis, opposite Quebec, but as yet the necessary concrete platforms have not been laid down.

The caponnières of these forts are armed with sixteen 32-pr. carronades; a poor substitute for the complete armament of rifled guns offered as a free gift by the Imperial Government, which was as follows:—

	On B. Traversing Platforms.	On Traversing Carriages.		
No. 1 Fort ..	7 7″ B.L.R.	4 40-pr. B.L.R.	8 10″ mortars	12 capr. guns.
No. 2 Fort ..	10 ,,	,, ,,	7 ,, ,,	10 ,, ,,
No. 3 Fort	10 ,,	,, ,,	7 ,, ,,	10 ,, ,,

One of these guns is lying in the park of the old Artillery Barracks at Quebec, intended to be mounted in an angle of the works commanding the head of Dorchester Bridge—the only approach to the city from across the St. Charles River. Before leaving, the Royal Engineers laid down the racers for this gun, but the concrete has never been filled in. The remaining two were sent, in 1874, to Kingston, where they now remain in charge of "A" Battery School of Gunnery.

This class of gun is almost obsolete in the British service. It is a good gun for land defence, is extremely accurate, and from the comparatively large capacity of its common shell, which weighs, filled, 98 lbs., bursting charge 7 lbs. 10 oz., would be very effective against

[1] An exhaustive pamphlet on "Mitrailleuses or Machine Guns," has been written by Capt. J. F. Owen, R.A., Capt. Inst. Royal Gun Factories, and their tactical use treated of in a lecture, entitled "The Gatling Gun: its Place in Tactics," by Capt. E. Rodgers, F.R.G.S., Journal of the Royal United Service Institution, No. LXXXII.

earthworks. The other projectiles used with this gun are segment and shrapnel shell and case shot. We have no 7-inch shrapnel in the country. Large quantities of this projectile are, or were lately, lying piled in Woolwich Arsenal, and probably might be obtained at a low cost. The complicated and delicate breech mechanism is against the gun, and has been known, in the severe winters of this climate, to become immovable, from the oil or drifting snow freezing between the bearings. An Armstrong armourer and peculiar tools are needed to keep it in order; the vent-piece requires constant attention, and the special stores and fittings used with it are many and varied.

Some years ago, two 64 32-pr. Palliser converted, and three S.B. 32-prs., with their carriages and stores complete, were handed over by the Imperial authorities at Halifax as a free gift to the Dominion. They have been mounted for drill purposes by the Artillery, and form an addition to the heavy ordnance on Canadian charge.

There are also three 32-prs. and an old iron 6-pr. mounted on an earthwork commanding the entrance of the bay of Charlotte Town, Prince Edward Island.

Field Artillery.

There are in Canada sixteen batteries in all. Until 1871, these corps, with one exception, were armed with S.B.M.L. bronze pieces, three guns and one howitzer to each battery. Since then, however, they have nearly all been provided with the latest 9-pr. M.L.R. gun of 8 cwt., and the most modern wrought iron carriages with Madras wheels from the Woolwich Royal Gun and Carriage Factories.

There are sixty of these guns now in use by the Canadian Militia. The 9-pr. of 6 cwt. would perhaps have suited our purpose better.

The Halifax Field Battery alone was then, and still is, served out six of the B.L.R. 6-pr. guns of 3 cwt. (Colonial Service).

Waggons were not imported with the 9-prs., with the exception of four which were given to the London Field Battery.

The two Schools of Gunnery have also these guns, and there are four at Red River, in possession of the Winnepeg Field Battery.

The North-West Mounted Police have in charge four 7-pr. M.L.R. mountain guns, 200 lbs. weight, and two 9-pr. 8 cwt. M.L.R. guns. There are no other pieces in the north-west belonging to the Dominion except a few S.B. bronze field guns and some Coehorn mortars at Fort Garry, Manitoba.

During a late discussion before the members of the Royal Colonial Institute, on Capt. Colomb's paper on "Imperial and Colonial Re-"sponsibilities in War," "Capt. Bedford Pim, M.P., expressed indig-"nation at the supineness of successive Governments with reference to "the defenceless state of Vancouver's Island, the depôt for all the stores "for our naval forces in the Pacific. If Russia within the next few "months were to declare war against us, Vancouver's Island, with all "the stores, would be at her mercy. As to our fleet, Russia having a "larger force and means of telegraphic communication with them, "which were not at our disposal, would be able, long before our ships

"on the Pacific station could hear of the declaration of war, to dis-
"pose of them in detail."

Our fellow-countrymen in British Columbia generally are alive to the fact of their having no adequate supplies of material wherewith to defend themselves, and several articles have of late appeared in the papers on the subject.

At St. John's, Quebec, and Montreal, points liable to be attacked by armoured ships, some of the heavier guns should be mounted, such as those at Halifax, 12, 18, and 25-ton guns; notably on the formidable fortress of Quebec, the key of Canada, where there is a battery of Canadian Artillery to take care of and, if necessary, use them.

The fifteen 64 32-pr. R.M.L. Palliser converted guns of 58 cwt., now arriving, will be a great accession to the Canadian armament; but they are now used as shell guns only in the English service, and no Palliser projectiles have been sent out with them. With the Palliser chilled shot and a battering charge they could pierce, at short ranges, the weaker ironclads.

From the high command of the Citadel of Quebec, projectiles from these guns aimed at the decks of ironclads would tell with good effect. A vessel's deck, when approaching bow on, offers a favourable parallelogram of error, elevation being a far more difficult matter than direction.

The fact that the present supply of 32-pr. carriages and side-arms would answer also for these guns was an economical inducement for their purchase.

Some guns of a heavy nature mounted *à fleur d'eau*, at Indian Cove, or at the head of the Island of Orleans, would command the channel.

It is to be hoped that the 64 32-prs. are but the *avant-garde* of some of their larger brethren, and that the eastern cities of the Dominion may be put in a position to reply in a sterner tone if called upon to speak at all—an event in these warlike times perhaps not wholly improbable.

L'Aisné in his "Aide-mémoire portatif du génie" (Paris, 1861), lays down the formula for the whole number of guns to defend a bastion fort, as follows:—No. of guns = 146+5 (M.-2), M. being the number of bastions. Taking the fortress of the Citadel of Quebec with five bastions we would have 146 + 5 (5-2) = 161 guns.

It is to be presumed that this formula would still hold good unless there existed a great difference in weight of metal between the guns of the besiegers and besieged. The stronghold just alluded to is armed, at present, with nine of the weakest class of garrison rifled guns in the service and a few obsolete smooth-bores.

The armament proposed for this fortress by the Imperial Government was as follows:

For Quebec Citadel and works facing the river, as approved 9/5/68, Canada, $\frac{5}{9\,1\,3}$:

9″	M.L.R.	12 tons	9
7″	„	7 „	4
7″	„	82 cwt.	13

Caponnière guns	39
64-pr. B.L.	9
24-pr. S.B.	10

As long as our present relations with the Empire continue, it is scarcely likely that we shall go into the manufacture of cannon, or even military small arms, however desirable it may be that the material used with them should be made in this country.

Ammunition.

The supply of ammunition and artillery-material generally is exceedingly small. From the reports of Lieut.-Colonel Wily, Director of Stores, it will be seen that about 100 rounds per gun for land and 200 for coast defence was given us in 1871.

Since then a considerable quantity of shot and shell has been expended at practice by the different batteries; what ought to be the service ammunition having to be so used, as there is no proper reserve in the country.

Cartridges are made up in the Laboratory at Quebec by the men of the Gunnery School, and supplied to the Dominion.

There is a proportionate supply of fuzes, tubes, &c., they are not, however, improving with age, and their district distribution is rather eccentric.

The regulations on this head for the Royal Artillery are given in Army Circular, War Office, 1st December, 1876, Clause 170, as follows:

"Garrison Artillery.—Fuzes and Tubes.—1st. The proportion of "fuzes and tubes to be maintained for Garrison Ordnance will be as "laid down in the details contained in the Equipment Warrant, 1876. "(Revised Army Regulations, vol. III), pages 59 to 76. 2nd. Half "of these proportions will be in charge of the Royal Artillery; the "other half will, in time of peace, be held in reserve, by the Ordnance "Store Department, at the depôt upon which the forts and batteries "are dependent for their supplies."

The Boxer wooden time fuze gets to burn slowly if kept too long, possibly from the sulphur in the composition deteriorating. These fuzes might with advantage be made in the country.

The 7″ B.L.R. gun here has for its percussion fuze only the old obsolete Pillar fuze, fitting the Moorsom gauge of the shells on charge. These fuzes, besides being obsolete, are not now reliable from sheer old age. The Dominion Inspector of Artillery has applied for a supply of Pettman's G.S. percussion fuzes for these guns, and there should be a store of them on hand.

The wooden carriages, gyns, quoins, tampions, skidding, levers, handspikes, platforms, sponge-staves, rammers, and wooden stores generally, which are used with garrison and field guns, are decaying and being expended by wear and tear throughout the country, and there is no provision at present for their being replaced by any manufacture in the Dominion. We ought not surely to import wood goods into Canada at a cost of probably about three times that at

which they could be made here, the staple export of the country being timber.

Of the woods used for military purposes we have oak, beech, ash, rock-elm, fir (pine and spruce), cedar (for ammunition boxes, fittings, &c.), chesnut, hickory, birch, rock-maple, walnut, and for ground platforms, juniper, hakmetack, &c.

It is said that a ship came into Halifax a few years ago from England, laden with birch-brooms, step-ladders, brushes, scrubbers, broom handles, &c., for the use of the troops, and it is a matter of history that the flagstaff of the Citadel of Quebec had to make two voyages across the Atlantic before being qualified for its present elevated position.

Within our own Dominion we have also mines which can supply iron equal to any English or other obtainable—notably the mines and works at Londonderry, Nova Scotia, which turn out iron and steel of the finest quality.

Supply of Small Arms.

There are at present in Canada about 80,000 stand of Snider-Enfield rifles, long and short, serviceable and *unserviceable;* also 2,500 new Martini-Henry rifles of the pattern now in use in the British service. The latter have not as yet been issued, and it may become a question if they ever should be, unless the arm is adopted *in toto* and supplied to all rifle corps of the Volunteer Militia. Confusion in the supply of ammunition might possibly happen, and would not be a good feature.

Besides the above, arms and accoutrements for 1,000 men were sent in 1872 to Victoria, British Columbia.

The Snider-Enfield is an excellent soldier's weapon, and is most specially suited to the Volunteer services. The mechanism is simple, strong, and little liable to get out of gear, and when it does so, it is easily repaired.

As an arm of precision, it is wonderfully good up to any range likely to be often required in a thickly wooded country such as Canada.

Although having a slow twist in the rifling, and a cartridge containing only a charge of 2½ drachms of F.G. powder, with a cylindro-conoidal bullet of ·577 diameter, great accuracy is obtained by the hollowing out of the centre of the bullet, giving increased centrifugal force. The space left in the head of the ball used to be filled up by a wooden plug, but in the latter make this space is left void, and the top is spun over with lead. The open space in the centre of the base is filled up with a pressed clay plug.

Including the Reserve Militia with the active force, the number of fighting men in Canada liable in case of war to be called out, numbers some 600,000 to 800,000 men; should there not be a far larger number of rifles in the country?

There must be in store in England any amount of serviceable Snider-Enfields which have been replaced in the Army by Martini-Henrys. Could not a number of the former, sufficient to form a

proper reserve in Canada, be obtained from the Imperial Government by the Dominion at a low cost?

The Martini-Henry has certainly a flatter trajectory and longer range, but it is a more expensive and complicated arm, and has also a much greater recoil, probably owing chiefly to the high pitch of the rifling. This latter point is very much against it. No ordinary soldier will ever make cool and accurate shooting with a kicking weapon.

For pistols we have only a small supply of old Colt's revolvers, using the obsolete cap and paper cartridge. We ought to have Adam's Army Service pistol, a breech-loading central-fire revolver with copper cartridges.

The Snider ammunition has so far been all supplied by purchase from the Imperial Government; much of it is very old, and greatly deteriorated. That of mark IV, V, and VI, some dating back as far as 1862, is not to be depended on, and now for rifle matches a later make up to mark IX is bought by private individuals from importers. There is a small supply of mark IX in store, but it is only issued on repayment.

These cartridges, and many other of the stores used, might advantageously be made in this country at a saving to Government sufficient to nearly double the amount now available from the Militia Grant for such purposes. We ought also to take into serious consideration the probable stoppage soon of the manufacture in England of Snider ammunition, that arm being no longer the weapon of the Army.

Taking the statistics furnished in the yearly Militia Reports by the Director of Stores for the last two years (1875-76), we find that the issue and sale of Snider cartridges, ball and blank, amount to no less than 2,503,184 rounds!!!

In the last year, 1876, the number of rounds sold to the different Rifle Associations and for individual target practice, amount to 511,302, with an issue by Government for Militia practice of 320,973: in all 832,275 rounds, exclusive of course of an immense number of cartridges purchased from importers for private practice, of which no statistics can be obtained.

Looking at the returns of the last three years, it will be seen that the sale of ammunition to the Rifle Associations, corps, and private individuals for practice, was as follows:—

1874	142,040	rounds.
1875	231,870	„
1876	511,302	„

Doubling every year! Surely this is most gratifying, as showing the great and increasing interest taken by all ranks of the Dominion Militia in perfecting themselves in the use of their weapons. Much of this good effect is doubtless due to the encouragement given by the various Rifle Associations, and notably by the "Dominion of "Canada Rifle Association," under the presidency of Lt.-Col. C. I. Gzowski, whose exertions for and liberality towards Canadian marksmen can scarcely be over-estimated.

In 1875 and 1876, 36,261 lbs. of gunpowder and 22,000 friction tubes, with the usual proportion of shot, shell, fuzes, &c., were expended for field and garrison artillery in practice.

The Dominion Artillery Association, lately organized by Lt.-Col. Strange, R.A., Dominion Inspector of Artillery, is having the same good effect in fostering gun practice; though it is only right to say that it cannot be expected to develop in the same way the expenditure of artillery ammunition until the subscriptions to this Association are largely augmented, as private practice with this arm can rarely be carried on.

The above figures show conclusively the large and rapidly increasing expenditure of material controlled by the Dominion Government. Let us hear what Lt.-Col. Robertson Ross, formerly Adjt.-General of Militia, has had to say on the subject of these stores being manufactured in Canada. His remarks on this subject are embodied in his report on the state of the Militia, and date back as far as 1872.

"Hitherto the supplies of uniform clothing, military equipment, "small arms, small arms ammunition, rifled field guns, ammunition "for field and garrison artillery, &c., &c., and military stores generally, "have been obtained almost entirely from the Imperial Government, "or from private contractors in England.

"It appears to me that the time has now arrived when an alteration "in this system might be adopted to a very great extent with advan-"tage.

"The desirability of expending in the country, as far as possible, "the money voted for the annual supply of these stores is obvious, "but I would especially call attention, on military ground, to the "necessity for commencing the manufacture of small arm ammunition, "and such warlike stores as are annually required for practice, and for "the maintenance of a sufficient reserve.

"As regards gunpowder, an article of the first military importance, "and which could not be obtained in time from England should a "sudden emergency arise, Lt.-Col. French,[1] Inspector of Artillery and "Warlike Stores (formerly Inspector of Warlike Stores for the "Imperial Government at Quebec, and consequently a competent "authority) has reported to me, on this subject, as follows:—

"'Having reference to the ammunition required for gun practice "'for the current year, I have the honour to point out that for various "'reasons it would be desirable to ascertain if the powder could not be "'manufactured in the country.

"'In December, 1871, I inspected the powder mills near Hamilton, "'and I feel satisfied from that inspection, as well as from conversa-"'tion with the manager and foreman, that a suitable powder for "'heavy guns could be produced at those mills.

"'The fine brand of powder known as "Dominion Rifle" is an "'excellent powder; I have used it a great deal myself, but the fact "'that it is used in a great measure by small-bore riflemen is sufficient "'proof of its excellence.

[1] This Officer, while in the Dominion, did much for the Canadian Militia of his own arm.

" ' It is, I suppose, needless for me to mention the advisability of " ' encouraging the manufacture of gunpowder in the country; at the " ' same time it will be necessary, if Government should contract with " ' manufacturers for this article, to look closely after its manufacture, " ' in order that the conditions may be as similar as possible to the " ' manufacture of the powder at present in store.

" ' I have received from the Superintendent of the Government " ' Powder Factory at Waltham Abbey, England, specifications for the " ' supply of powder by contract, &c., &c. I shall be happy to submit " ' the necessary conditions if required.'

Col. Robertson Ross continues: " And with regard to the general " question of the manufacture and repair of warlike store in this " country, that Officer reports to me as follows:—

" ' I have the honour again to bring to your notice the advisability " ' of commencing, even on the smallest possible scale, the manufac- " ' ture and repair of those warlike stores most needed for the defence " ' of this country.'

" I would submit for your information the following figures, which " will be in themselves a sufficient proof of this fact on the score of " economy; from a defensive point of view, however, the economy is " a secondary consideration:—

Imperial Government Prices.	No. 1 Balance Sheet.	No. 2 Balance Sheet.	
	£ s. d.	£ s. d.	
R.L.G. gunpowder, per 100 lbs...	2 10 11½	4 7 4½	Vide " Priced Vocabulary, 1871."
Snider cartridges, per 1,000:—			
Ball.....	2 16 10	3 10 3	
Blank.....	1 11 0	1 14 1	

" No. 1 Balance Sheet is the cost of production, No. 2 is, I presume, " a protection to British manufacturers.

" The Canadian Government have to pay 5 per cent. more than " No. 2 Balance Sheet if the articles are purchased in England, or " 15 per cent. more if purchased in the Dominion. Thus, the gun- " powder would cost the Dominion almost 100 per cent. more than its " cost in England.

" In addition to this 100 per cent., there is the fact that for making " up cannon and small arm cartridges, repairing small arms, gun " cartridges, &c., there are numbers of public buildings lying idle, the " use of these rent free would be almost a set-off to the increased " price of labour in this country, particularly if it be borne in mind " that the labour of children is employed to a large degree in certain " of the minor operations.[1]

" I would in conclusion submit that the establishment of an arsenal " on a small scale may be pressed on the attention of the Government."

Colonel R. Ross says further: " With regard to the suggestions of the

[1] In this year of grace, 1877, labour in Canada can be obtained as cheaply as in the mother country.

" Inspector of Artillery and warlike stores, I concur entirely in the " views submitted by that Officer."

Reference to the Militia estimates shows that a very considerable sum is voted annually for military stores, &c.; for instance, in the Financial Estimates for the year ending 30th June, 1872, the following sums were voted, viz.:—

	Dol. c.
" Ammunition	139,109 00
" Clothing	130,000 00
" Military stores (including storage however)	85,690 00
" Ordnance stores and equipment for field and garrison batteries	33,606 00
" For improved fire-arms	142,055 00
	530,460 00

" Although this amount exceeds the average expenditure, it is evi- " dent that a very large sum of money has hitherto (and I believe " unavoidably) been expended out of the country, the greater portion " of which might now, on military and other grounds, be expended " with advantage in the country."

These sound recommendations have been strongly seconded by Lieut.-Colonel Strange, R.A., Dominion Inspector of Artillery, in his report of 1874, and also by Lieut.-Colonel Irwin, Inspector of Artillery.

The logic of such figures as the above seems undeniable, and it is only to be wondered at that our rulers, so keen in reducing the estimates, should not as yet have seen fit to take up the question.

Why should we not have an establishment started for the manufacture of *munitions de guerre*, when, besides other considerations, such an obvious saving can be made?

There would, of course, be a certain outlay necessary in the purchase of "plant;" but the difference in price between Balance Sheet No. 1 and Balance Sheet No. 2 is so great that it is only fair to suppose that the saving to the country in the first year alone would amply cover such expense.

No General would like to have to fight in a theatre of operations more than 3,000 miles from the base of supply; and the problem is not improved by the base in question being nearly inaccessible during about five months in the year.

The reserve of both artillery-material and small arm ammunition is so small[1] that, in the event of hostile attack, large supplies would be

[1] In his report for 1876, the Major-General commanding says: " Our reserve of " rifle ammunition is particularly small; we have only 150 rounds for each stand of " rifles in the country. This is, at least, one-half too little, keeping in view the " rapidity with which breech-loading arms can be fired. In the item of powder, too, " our reserve is too small for garrison or field artillery in time of necessity. In 1875 " the general reserve in store throughout the Dominion was only—

" Gunpowder	188,576 lbs.
" S.A. ammunition	6,902,163 rounds.
" Snider rifles, long and short	19,820
" Camp equipment for about	50,000 men."

wanted from the mother country. At such a time she would be driving her magnificent factories of war material at high pressure for her own needs, and our demands would come at a truly inconvenient season.

Would it not be in our interest in every way to do something in this line for ourselves?

On Government land at Quebec, and surrounded by vacant ground to a safe distance from the dwellings of the city, lies a group of laboratory buildings, built for Imperial uses by the Royal Engineers, and well adapted as workshops for the purpose suggested. They are in perfect order, and a part of them is at present used by the Quebec Gunnery School for making up cartridges, &c., for the Dominion. Large earthen traverses are erected between each building to lessen the effect of an accidental explosion, should such a thing occur.

There is plenty of Government ground for storehouses, and in this place a second-class arsenal, which is what we need, could be easily established.

Here under the guns of the Citadel, and the supervision of a scientific Officer of the Royal Artillery, might be commenced a manufacture, on however small a scale, of material needed and used in Canada.

Artillery Officers superintending the manufacture of material, even on a small scale in such an arsenal, would furnish data as to cost of production which would be useful in checking the prices of contractors on a larger scale. Here, also, all warlike supplies furnished could be tested for acceptance.

The new and delicate means for proof and examination of gunpowder as carried on at Waltham Abbey are given in detail in the "Hand-book of the Manufacture and Proof of Gunpowder, as carried "on at the Royal Gunpowder Factory, Waltham Abbey," by Captain F. M. Smith, R.A., Assistant-Superintendent.

Le Boulengé's chronoscope used there in testing the action of the gunpowder when fired has been very fully described by Lieutenant C. Jones, R.A. (a Canadian), in a pamphlet on this subject.

In that ably written book, the "History of the Royal Artillery," by Major F. Duncan, R.A., we read how in the olden time the command of Albert Borgard, 1st Colonel of the Regiment, and a well *foughten* old man he was, contained within itself, with its quaint old staff of engineers, petardiers, matrosses, tinmen (whatever they may be), tentmakers, and artificers of any kind, the skilled artisans necessary for supplying all the wants of an Artillery "Trayne."

Coming down to a later period, the immense Depôt Brigade of Artillery drivers at Woolwich and elsewhere, doing all the carting work previous to the Crimean War, furnished the means of an immediate and great extension to the Artillery.

Gunners also were largely employed in the arsenals and workshops, thereby obtaining a thorough knowledge of the stores they would have to use, and ought to be familiar with.

Turning from great things to small it is admitted that for purposes of instruction many more horses are needed at the two Gunnery Schools, but they cannot be given for economical reasons.

It is said that at one station over 3,000 dollars per annum is paid to contractors for cartage for general militia purposes. This sum would keep 25 or 30 horses more at the school, and an efficient field battery could be maintained, doing all the work and drill besides, without any extra expense to the country.

In such workshops as have been proposed above, the questions of supply, care, and repair meet on a common ground; and the efficient attainment of all these three vital ends would be much fostered by such establishments.

Labour is extremely cheap in Canada, and more especially in Quebec, in the winter months. In the manufacture of fuzes, tubes, cartridges, and small stores of forts, child labour is largely employed.

The following quotations are from the Royal Artillery Institution prize essay of 1872, on the "Establishment and Organization of an "Arsenal," by Lieutenant E. H. H. Collen, R.A., Staff College, Sandhurst. Out of that clever work we will try to choose some portions which bear on our subject. He says:—

"If, then, it may be conceded that the time is fast approaching "when the soldier who aims at distinction must understand and "appreciate every part of the great machine by which an Army is "worked, I may hope to attract to the subject of this essay the atten- "tion of those who would pass it by as not concerning the active duties "of their profession, and as a matter that might well be left to the few "who have made this branch of the Artillery Service the business of "their lives. It requires, however, but little consideration to show "how deeply and intimately is connected the duty of supply with "those military operations which form the chief study of soldiers. "Few of us, indeed, may be actually called upon to organize an "arsenal, but still every Artillery Officer should consider the principles "which should govern the working, while our brother Officers of "other branches of the Service will not find it vain and unprofitable "labour to look into a matter which may be of deep importance to a "General and his Staff, whether in defence of this country or in "foreign expeditions or wars.

"The national scheme of military organization which has been so "lately placed before the public, recognises completely that decen- "tralization in respect to warlike stores, which must accompany an "attempt to form a force of the higher tactical units, each complete "in itself.[1]

"An arsenal is an establishment for the construction, repair, receipt, "storage, and issue of warlike stores.

"Arsenals may be divided into two classes:—

[1] "According to these arrangements, the troops of the reserve would be equipped "for either of the foregoing objects, in respect to arms, accoutrements, clothing, "or expense ammunition from the depôt centres; the regular and reserve forces "both obtaining camp equipage, field stores, and reserve ammunition from the dis- "trict issuing stores." Report on the organization of the various land military forces of the country, by a Committee assembled by order of the Secretary of State for War:—

. . . . . .

"First-class Arsenals.
"Second-class "

"In first-class arsenals every want of an army and the military "service in respect to the munitions of war must be provided for."

With this class we have not, however, at present to deal, but will consider the subject of a second-class arsenal only.

". . . . In an arsenal of the second class, the great manufac- "turing establishments of the first-class arsenal are compressed into "workshops for partial construction and for repair; the store depart- "ment being of equal magnitude and importance with that of the first- "class arsenal. Provision must, however, be made for manufacture "to a limited degree, so that by the judicious position and arrange- "ment of our arsenal, we may be prepared to utilize the manufac- "turing resources of the district in time of pressure or danger.

"With the construction of guns, and the various elaborate pro- "cesses to which the metal is subjected before being placed in the "hands of the artilleryman, a second-class arsenal is hardly concerned, "although its workshops must be adapted to perform certain minor "operations connected with ordnance.

"While it would be necessary to provide for the chief kinds of "ammunition used for field purposes, it would not be possible to have "such an establishment as would suffice to manufacture the numerous "varieties of ammunition required for siege and naval purposes.

"Again, while the second-class arsenal in peace time would be "unable to turn out large batches of carriages, it should be able to "make and repair gun-carriages and other carriages used in the field, "and form the nucleus of a larger establishment for this purpose. In "addition, the second-class arsenal should possess workshops for the "repair of small arms, and for the manufacture on a limited scale of "harness, saddlery, and accoutrements."

Here it may be remarked that anyone who had an opportunity of seeing Canada's show of saddlery and harness at the late Centennial Exhibition at Philadelphia, would scarcely doubt our capability of turning out a make of these articles which would contrast favourably with anything to be obtained elsewhere. Further on, the author from whom these quotations are taken continues:—

"Such an arsenal would probably consist of large establishments "for storage, with small factories or workshops for repair and replace- "ment, . . . combined with the adaptation of any existing "factories to the manufacture of such munitions of war as could be "made in the country."

With regard to the conditions which govern the position of an arsenal, which should invariably be governed by strategical considerations, he adds:—

"An arsenal should be situated at the base of operations, whether "for offensive or defensive purposes. Jomini draws a distinction "between the base of operations and the base of supply, but this dis- "tinction cannot apply to the furnishing and replacement of munitions "of war. In defensive operations it must be situated near that point "which is the best adapted in all respects to form a last stand-point

"against attack, and from which a successful counterstroke may be "launched at the assailant.

"It must be secure from attack, placed at that point from which "the transport of stores can be effected with the greatest facility, "whether by rail, water, or road—a combination of all these means of "transit being the most to be desired—to the various parts of the area "to be supplied.

"It should never be too near the frontier or the outer line of "defence.

"An arsenal should be placed so that it can, with facility, draw "in the resources of the country in minerals, timber, and the great "mass of raw material required for the construction of munitions of "war.

"Safety and facility for supply and transport are the chief con-"siderations which must decide the position of an arsenal; and "whether for offensive or defensive war, it must be protected by such "fortifications as shall ensure its defence by a small force against "superior numbers, and oblige the latter to undertake its siege or "investment with every probability of final failure.

"Provided these conditions are fulfilled," he continues (and they certainly seem to be, in the case of Quebec, in every particular), "at "or near the centre of a manufacturing population would be found "the most suitable position for the establishment of an arsenal, for in "a position of this kind we might expect to find men, machinery, and "material which could in a great emergency be diverted from their "ordinary business, and applied to the production of warlike stores, "supplementing and expending the smaller organization of peace "time.

"In foreign states we look for large arsenals at the great pivots "and bases of offensive and defensive operations guarded by fortresses[1] "which have grown up with the necessity for the supply and renew-"ment of the manœuvring armies."

With regard to the administration of such an arsenal, our essayist goes on to say:—

". . . . I think few will be inclined to dispute the assertion "that the manufacture and supply of warlike stores require special "training, and that in addition to the knowledge required of stores "in their *passive* state, the officer charged with supply should have a "practical knowledge of the *use* of the same. Without this, while "it is possible that a department might supply stores with regularity "in the time of peace, it would probably fail in the time of war or "emergency, because it would not know what stores should take pre-"cedence in manufacture or despatch, nor what may be supplied in

[1] "But these should be something more than fortresses—they should contain "sufficient material for a great army in artillery fire-arms, provisions of all kinds, "workshops, arsenals, hospitals; in fact, collecting all the raw material which "naturally flows from the surrounding district into a great city, they should be "capable of converting it, by means of a large population of artisans, and of exten-"sive manufactories, into the material of war—of turning brass into cannon, iron "into projectiles and rifles, wood into trains of waggons, wheat into biscuit, canvas "into tents, &c."—Hamley's "Operations of War, 2nd Edition, p. 307.

"lieu of those of another kind when the stock of the stores required "is exhausted.

"But it may be asserted that it is impossible to obtain a man "practically acquainted with, and competent to deal with all natures "of stores. This is perfectly true; but an Artillery Officer who knows "his profession and the requirements of the other branches of the "service, who has passed through the manufacturing courses, will "probably be found to best fulfil all the necessities of the case, provided "he is assisted by men capable of dealing with the work to be done "in a practical fashion.[1]

"The magazines, although forming an integral part of the ad- "ministration of an arsenal, would be placed in positions of safety, "consistent with facility of supply. The chief points to be attended "to are:—

"(1.) Precautions for safety.

"(2.) Freedom from damp.

"(3.) Ventilation.

"The regulations for the safety of magazines do not need repetition "here, as every Officer is expected to know them as contained in the "Queen's Regulations.

"The separation of combustible stores is an important point, *i.e.*, "the division of powder, which should be kept by itself, from other "stores: tubes, fuzes, cartridges (empty and filled), &c., being kept "in a separate magazine. In all magazines very clear arrangement "is necessary, and a list of the stores contained should always be "placed on the exterior door, the quantity being inserted in a column "which may be renewed from time to time by pasting over strips of "paper. All cases and barrels should be legibly labelled. . . .

"In a second-class arsenal. . . . large factories would be re- "placed by workshops for the performance of minor processes ana- "logous to the larger operations. We should require:—

"1. A workshop containing lathes, and all machines for turning, "boring, and fitting.

[1] Upon this portion of the subject the recommendation of the two Committees, known respectively as Lord Strathnairn's Committee on Supply and Transport, 1867, and Lord Northbrook's Committee on the Conduct of Business in the Army Departments, 1870, bear very strongly.

The opinion of the former was, as is well known, in favour of a distinct Ordnance Department, and was as follows: "That the custody and management of arms and "munitions of war is so special a duty that it could not be conveniently connected "with that of other supplies, but that it should be a distinct branch in close connec- "tion with the Royal Artillery, who are trained and professionally qualified for such "duties."

Lord Northbrook's Committee, however, considered that this would destroy "unity of administration," and recommended that the Control Department should consist of two main sections in the War Office and in the field; one for providing and issuing articles required for the daily consumption of an army, such as food, forage, fuel, and light, and for the administration of transport; and the other for the receiving and issuing of all other stores. The latter division should be placed under an Officer who has a professional acquaintance with munitions of war. . . . The education and training which an Artillery Officer receives is precisely that required for an Officer of this division of the Control Department.

. . . . . .

"2. Smith's shop and forges.

"3. (*a.*) Carpenter's and wheeler's shops, where carriages might "be made and repaired; (*b.*) cooper's shop; (*c.*) painter's shop.

"4. Collar-maker's shop for repair of harness, tents, &c.

"5. Laboratory where all the simpler kinds of ammunition might "be made up.

"6. Armoury workshops with all the lathes and tools for the repair "of small arms."

Care.

The care of the heavy ordnance which is mounted and in Artillery charge in Canada is now almost exclusively in the hands of the Gunnery Schools, in which—working under the orders of the Inspectors of Artillery—the Officers, master gunners, with their staff of district gunners, Armstrong armourers, sergeants, &c., keep the armament in a high state of efficiency.

The S.B. cast-iron guns are examined, scraped, and painted regularly, those on land fronts once in two years, and those on sea fronts once a year. Gutta-percha impressions when thought necessary are taken at the bottom of the vent to detect the commencement of cracks round the lower extremity of the copper bushing.

This should always be done after every 200 rounds fired with projectiles.

If found necessary the guns are re-vented, through-vented, or condemned, as the case may require, by the Inspector of Artillery, after examining the impressions taken by the Armstrong armourers.

The 64 32-pr. M.L.R. guns have a space for a shoulder cut in the metal of bore where the bushing enters, and the copper is set up from below into this. With the appliances now available these guns could not be re-vented in Canada.

Owing to the impossibility of furnishing the sentries who used to mount guard during the old *régime*, those guns not in use have their sights removed, preserving screws put in, and their vents stopped with putty.

The latest regulations for the examination of rifled guns are given in a pamphlet containing "Directions for the Preservation of the "Sights and Fittings, and for the Examination of Muzzle-Loading "Rifled Guns, &c." War Office, August, 1872.

As regards the guns we have in Canada, the 7″ B.L.R. and the 64-pr. M.L.R. (converted), should be examined regularly after every 100 rounds with projectiles; smaller guns after every 150 rounds.

On the subject of "care" the Directors say, "It is necessary in "order that rifled guns may be always kept in a serviceable condition "that the bore of such guns, whether B.L. or M.L., from which "practice is carried on, should be kept slightly oiled to prevent "rusting. At the close of each day's practice they will accordingly "be washed and placed under metal, and as soon as dry will be oiled "with a sponge and the muzzles closed with tompions. When guns "are not in constant use the bores will be lacquered, and the bright

" parts about the breech of the B.L.R. guns greased with the follow-
" ing mixture:—

" Tallow, 3 parts.
" Lard oil, 1 part.
" White lead, about 1 lb. to a gallon.

" The vent-pieces, and all other fittings except the screws, will be
" removed."

The M.L. rifled guns are liable to scoring of the bore, an erosive action due to the rush of gas round the projectile, particularly over the seat of the shot, and to cracking of the steel inner tube. The extent of both is ascertained by gutta-percha impressions, and the occurrence of the latter in the 64-pr. and larger natures is indicated by the tell-tale hole, or gas escape.

Our 64 32-pr., being a converted cast-iron gun, is much more dependent on the strength of its tube than a wrought-iron one.

The 9-pr. M.L.R. field guns and fittings should be kept clean and slightly oiled, and require attention from time to time when not in use to prevent rusting. Except during the annual training they are usually looked after by men employed for the purpose by the Commanding Officers of Batteries.

If any of these latter are of the "spit and polish" school, they may keep their guns very bright by the use of the following receipt:

A lacquer of—

Rectified Spirits of Wine	1 quart.
Dragon's Blood	4 drs.
Shellac	$1\frac{1}{2}$ oz.

Put on with a soft brush; it requires no rubbing.

For repair of the carriages see "Notes on the Manufactures of " the Royal Carriage Department," and supplementary chapter on the "Examination and Repair of Artillery Carriages, &c.," arranged by Major Oldfield, R.A., Assistant Superintendent Royal Carriage Department, in Griffith's Artillerist Manual, a book that ought to be in the possession of every artilleryman.

Memoranda of examination, or the "Medical History," as they are called, of each gun should be carefully kept, and this is regularly done at the Gunnery Schools, as far as the guns in their charge are concerned.

In this record are stated the defects of the gun at the time of its issue, the number of rounds it has fired, and the result of the examinations it has undergone.

The wooden carriages are also looked after and painted and puttied, but there is at present no provision for their repair, which is constantly needed, nor for that of platforms, and both are rapidly decaying everywhere.

It is scarcely necessary to remark how important it is that every Officer in charge of gunpowder magazines should be fully informed in every particular in connection with their care. Full instructions as to the use of the wet and dry bulb thermometer for finding the dew

point, and ascertaining the proper days for ventilation, and many other most important points are given in the "Regulations for Gun-"powder Magazines," issued with Army Circular, July, 1874. Every Officer of our Military Store Department, which has sole control of the magazines, doubtless is familiar with these regulations, and has the necessary instruments for enabling him to carry them out. Every fine day is by no means necessarily a suitable one for purposes of ventilation.

Fuzes and tubes can be kept in any safe and dry place. They are not allowed to be stored in a powder magazine on account of containing detonating composition; the same rule applies to small arm cartridges.

The other gun stores and material, such as side arms, tackles, &c., require little care, but much repair and constant renewing.

As for the care and repair of small arms Major-General Sir E. Selby Smyth, K.C.M.G., in his report on the Militia, 1875, writes as follows:—

"My former suggestion, for a permanent Adjutant on the Staff of "each battalion,[1] I do not urge, though fully persuaded of the "advantage, yet I find the idea not generally accepted, besides being "a greater expense than the estimates can at present afford. I still "adhere, however, to the proposal for a permanent sergeant-major "capable in the highest degree of instructing in drill, discipline, and "the duties of guards and sentries, who could also be the care-taker "of the armouries and clothing stores.

"The care of arms and clothing is full of difficulties in the peculiar "constitution of the Canadian Militia organization. I know they "should always, with certain unavoidable exceptions, be kept at the "head-quarters of the battalion. When rifle matches occur in rural "companies a case of arms could easily be sent for the purpose and "afterwards returned.

"The rifles have been in use for so long without examination by "an armourer, that I believe I am not exceeding the fact when I say "that a large proportion of them are not fit for active service. This "is really a very serious state of things—a soldier without his rifle or "carbine would be useless. I last year urged the necessity for skilled "armourers who should examine every rifle in use once a year, and "effect the necessary repairs.

"I again draw serious attention to this most important defect, and "earnestly advise that skilled armourers should be imported from the "small arms factory. Whether they should go round the various

[1] The appointment of a permanent adjutant and sergeant-major, and one trumpeter for each corps was also a feature in the Militia Bill of Major-General Sir P. L. McDougall, when that distinguished Officer was Adjutant-General of Canadian Militia. This Bill was most eminently suited to our requirements, and was, like its author, very popular with the Canadian Volunteers. Major-General D. Lysons, C.B., Quarter-Master-General, then Col. Lysons, when serving in this country, also drew up a Militia Bill, which contained a suggestion of this nature. The Government of the day lost office by failing to carry this efficient measure, but, well watered, it forms the basis of our present system, which, however, like the original, is weak in proper provision for the artillery arm.

" battalions and rural companies to repair the rifles on the spot, or " whether the rifles should be assembled at certain fixed stations, is a " matter of detail easily determined by ascertaining the most econo- " mical method. But, pray give us armourers to render these delicate " weapons fit for use."

To these able remarks nothing remains to be added. Arms kept together at the battalion head-quarters, as is the case with city corps, are sufficiently numerous to require the attention of a paid care-taker, and the rifles are properly looked after, as far, at least, as being kept clean is concerned.

In the country, on the other hand, in many cases, the Captains of companies have the care of their own arms, for which duty they receive an allowance of 40 dollars per annum.

They doubtless have the weapons properly cleaned, oiled, and stored away after the training, but if they are not looked at and gone over again *de temps en temps*, before the next year's turn-out, they will be in anything but good condition—even the best Rangoon oil will rust a rifle if left on any length of time, and if they happen to use any other, new rifles would probably have to be furnished before the next training.

There are depôts of material at Toronto, Kingston, Montreal, and Quebec, which ought, however, to be much larger.

The most important stores are those at Montreal and Toronto; both these places are unfortified and perfectly open to hostile attack.

It was at one time proposed to fortify Montreal, or rather to build a line of forts at St. Lamberts on the opposite side of the river, with a keep on St. Helen's Island, guarding the approaches to that magnificent work the Victoria Bridge, but this scheme has since been abandoned. Lt.-Col. Strange, R.A., Dominion Inspector of Artillery, in one of his yearly reports recommends instead to guard the *tête-du-pont* an *enceinte* of Moncrieff pits (armed with guns on Moncrieff carriages), double revetted with timber, and protected from assault by reverse palisaded galleries in the counterscarp of their ditches. This would afford protection to the commercial capital at a minimum of cost.

It would not be advisable to have large armouries in cities when no guard over them of any kind can be maintained. There are splendid corps of Volunteer Militia in each of the above-named places, but should a riotous mob attempt to arm itself by a seizure of Government property, the consequences might be serious.

In the nature of things, a Volunteer corps, however good, takes, unless actually under training at the time, many hours to muster to any considerable strength.

Chair à canon, if not exactly artillery material, is at least its *raison d'être*—so this much it may be allowable to say, that these difficulties and many others not coming under the subject of this paper, would be met by the embodying of corps as schools of cavalry and infantry, so strongly recommended by the Major-General commanding; or still better, by increasing the number and strength of the present Schools of Gunnery, and making them schools of all arms.

The present instructional staff would almost suffice with perhaps a slight addition, the great gain would be that the present necessarily employed men would suffice for the whole.

For instance, at each of the Schools of Gunnery there are of necessity guards, cooks, tailors, shoemakers, shoeing-smiths, orderly room clerks, a hospital establishment, mess establishment, provost, and in addition in this country the heavy duties of wood cutting, snow shovelling, &c.

These duties, done by a small isolated corps, would absorb nearly all available men, and render very difficult that instruction which should be the first object of a military school.

At Halifax, Quebec, Kingston, and Ottawa, should be the principal armouries and depôt centres with issuing stores in every military district. The three former cities are fortified posts, and the latter is a long distance from the frontier, and has, moreover, a very efficient militia force, including a fine field battery, a strong brigade of garrison artillery, with a battery of 24-prs. at Nepean Point, and the smart regiment of the Governor-General's Foot Guards.

The supply of British Columbia ought to entail separate arrangements. A depôt of material, and perhaps an arsenal, naval and military, might be established at such a place, for instance, as Penetanguishene.

Everything connected with the supply and equipment of our first line, the Active Militia, ought to be in the most perfect order, and so constituted as to be capable of indefinite extension without confusion, should a sudden strain come upon it. Writing about what would probably occur in the event of anticipated hostilities, Colonel Fletcher, in the lecture before alluded to, says:—

"What would the Government of Canada at once do? First, em-
" body the Active Militia; then complete to war strength the several
" batteries and regiments of Cavalry, adding guns, troops, and batta-
" lions, so as at least to treble the strength of the present Active
" Militia; bringing up, at the very commencement of hostilities, the
" number to above 100,000 men."

We have only 80,000 stand of arms in the country, and of these the General says "*a large proportion of them are not fit for active* " *service.*"

The days of fighting *à l'arme blanche*, are gone for ever among civilized nations.

Our reserve of small arm ammunition ought to be nearer forty than six million rounds, as at present; and there should be camp-equipment for at least the 100,000 men above mentioned.

That such a force would at once spring to arms is beyond question, as has been often proved of yore, and in more recent days at the time of the Mason and Slidell affair, and in 1866, when the frontier farms of Canada were wrecked, and her sons shed their blood in repelling the Fenian hordes.

If supplies for this number of men were on hand and they could take the field at once, sufficient time would be gained for the equipment of the paper army of the reserve, our *undrilled* landwehr.

Those corps now efficient, and there are many very fine ones, should be found in every requisite of a soldier, and be really ready to take the field at short notice in marching order complete in every respect. Probably but few could do this now; perhaps, strictly speaking, none, with the exception of those embodied at the Schools of Gunnery.

One regiment has no valises, another no havresacks; and none have any proper boots and shoes.

As articles of the very first necessity these latter have had honourable mention from Marechal Saxe, Wellington, and many a soldier since.

In this country, the men of our City Volunteer Militia Corps principally wear a boot with elastic sides, a narrow sole, and very high heels; the first day's march would lame half a regiment.

A large reserve of good boots for the mounted services, and strong shoes, something like the ammunition shoe of the British line regiments, might be kept on hand.

Should they show signs of deteriorating from age before being wanted they might be issued free to the force—which does not get too much encouragement at present—and a fresh supply obtained. It is presumed that boots may be treated of under the head of *munitions de guerre;* they are not, at all events, *munitions de bouche*, except perhaps in very extreme cases.

It behoves us in these warlike times to see that our house is in order, and to remember that we are part and parcel of a great Empire, over which the Eastern war-cloud looms rather darkly just now.

That we ought to do something more towards providing for our own defence, considering the protection so generously afforded us by Great Britain, will hardly be denied.

Even putting aside the sentiments of loyalty and patriotism so strong in all classes of the Dominion, and taking the practical and material view, let us remember that our merchant service is the third largest in the world, and, as has been pointed out by a late writer in the *Pall Mall Gazette*, in every sea sails under the ægis of the glorious old flag, and backed by the full power of the Royal Navy of the Mistress of the Seas.

In every port our seamen claim the aid and protection of the British Consul, and all this at no cost to ourselves.

True it is that our neighbours across the line keep up but a little standing army, but their case is not at all analogous to ours in Canada. They maintain a formidable naval force for the protection of their mercantile marine.

We have not a single Canadian ship of war, and rely entirely upon the splendid Navy of the little island which we proudly call our mother country; and yet with all the heavy insurance paid for us so generously by her, we have as yet scarcely shouldered any of the burden of the defence of the Empire.

The Kingston Military College is a step in the right direction; the establishment of a small arsenal of our own would be another.

We do not too greatly centralise our stores of war material, an error

which told so disastrously against the gallant French in the late war —their bravery and desperate valour were fatally handicapped by the want of supplies.

We do centralise, however, in peace time at least, the power of ordering the issue of our military stores. Doubtless this system would be modified in time of danger; but a great military principle is sacrificed—that of practising in peace what will have to be done in war.

The story of the Franco-Prussian War shows plainly a tale of sad disaster consequent upon these questions not being thoroughly worked up and arranged on a proper basis before the commencement of hostilities. France thinking herself ready, and clamouring for war, had her fields bathed in blood, and the two fair provinces of Alsace and Lorraine wrested from her Empire.

One writer says:—[1]

"Bazaine's first march was a short one and impeded by an enormous "quantity of baggage: he gives a further reason for delay in the fact "that the French Intendance, or Control Department, had stowed "away six millions of cartridges without telling him where to find "them, and, moreover, had themselves forgotten their whereabouts. "This gave the Germans time; they pushed forward as far as Mars-la-"Tour, with cavalry and guns, and struck the head of the French "advance, also cavalry apparently without guns. The French prepared "to charge, but the German cavalry, who masked their guns, wheeling "right and left, opened out and left the guns to work their deadly "destiny, and thus turn the tide of French retreat."

This was no isolated case, and the reasons are not far to seek and are matters of history.

Another author writes:—[2]

"Instead of having, as is the case with Prussia, army corps always "in an organized state recruited in the province itself and possessing "on the spot their material and complete accessories, the troops of "France were dispersed over the whole country, and the material "stored in crowded magazines in the most diverse places, so that in "the case of a division of the Army being ordered into the field for "active service, the artillery had to be ordered from one point, the "train equipage and ambulances from another, and the soldiers of the "reserve from every point of the compass. To this fundamental "defect must be added another of which no military man in France "could be ignorant, while so much depended on the intelligence and "firmness of individual Officers to bring order out of this chaos, the "Officers had no sufficient authority. The most trifling thing, a sauce-"pan, a camp-kettle, a havresack, an extra biscuit, required a Minis-"terial authorization, an express order from the Office of French "Contrôle at Paris."

The last paragraph describes pretty nearly our system. Surely an Officer entrusted with a high and responsible command might be

[1] Lt.-Col. Strange's Retrospect of the last great war.
[2] Elihu Rich's "History of the Franco-German War." Vol. I, page 224.

allowed to draw a saucepan or a biscuit. He could always be court-martialled afterwards for any malfeasance.

To quote another:—[1]

"The Intendance had concentrated all its stores at Rheims without "providing in the least for smaller magazines on the lines of march "of the troops. There was probably so much hesitation in determin-"ing what operation was to be undertaken that the march tableaux "were not communicated to the Intendance in proper time."

The French cry of "*Nous sommes trahis*" was incredible at the outset, but in the light thrown upon the subject by documents that have since been found, it does not seem so very unaccountable.

It is not meant that they were deceived by intent, but rather by the circumstance that a proper system of supply had not been thought out.

That Napoleon dared not trust his Army supplies out of Paris is a theory which may account for much that happened.

Letters from French Generals, found afterwards in the Tuileries, and published by the *Commission des Papiers*, are almost incredible. In the "Histoire de la Revolution de 1870–71",[2] we read:—

"L'entrée en Campagne, Général de Failly, Commandant 5me Corps "à Guerre—Paris.

"Bitche, le 18 Juillet, 1870.

"Suis à Bitche avec 17 bataillons d'infanterie. Envoyez-nous "argent pour faire vivre troupes, les billets n'ont point cours—Point "d'argent dans les caisses publiques des environs.—Point d'argent "dans les caisses des corps.

"De Failly."

"*Point d'Argent*," is a cry not totally unknown in connection with our own military supplies.

A General of Intendance writes:—

"Metz, le 20 Juillet, 1870.

"Il n'y a à Metz ni sucre, ni café, ni riz, ni eau-de-vie, ni sel, peu de "lard et de biscuit. Envoyez d'urgence au moins un million de rations "sur Thionville."

The General commanding the 4th corps at Thionville says:—

"Le 4me corps n'a encore ni cantines, ni ambulances, ni voitures "d'équipage pour les corps et les états-majors. Tout est complètement "dégarni."

There are many letters in the same strain. One leader alone was not troubled on this score. Général Michel writes:—

"Suis arrivé à Belfort: pas trouvé ma brigade: pas trouvé général de division: Que dois-je faire? Sais pas où sont mes régiments."

Such correspondence shows a state of fearful confusion as regards the supply of the Army, and in the fatal consequences that followed we can see the great importance of the subject.

Doubtless the Germans, so well informed on everything concerning the matter, were not ignorant of this state of French organization, or rather disorganization, and precipitated matters accordingly. History

[1] "The Franco-German War," by Col. A. Borbstœdt and Major F. Dwyer.
[2] Author unknown.

repeats itself; what often happened before occurred in this case and will occur again—not to us let us hope! Germany was ready; France was not, and the latter was attacked and defeated in consequence.

So true still, though so little thought of here, is the saying of the wise old Roman—

"*Si vis pacem, para bellum.*"

LECTURE.

Friday, 21st December, 1877.

Lieut.-General Sir DANIEL LYSONS, K.C.B., Quartermaster-General, in the Chair.

THE TELEPHONE AND ITS APPLICATION TO MILITARY AND NAVAL PURPOSES.

By W. H. PREECE, Vice-President Society Telegraph Engineers, and Member Institution Civil Engineers.

No one can deny the enormous value of the electric telegraph for warlike purposes. It has well nigh revolutionized the art of war. It has become a great weapon of offence, as well as a great shield of defence. Operations that were a few years ago impossible are now regarded as essential. The strategist in his office can now grasp a continent in his combinations. The actual manœuvres of armies can be controlled and directed like the toy figures of the game of Kriegs-spiel. The maintenance of the lines of telegraph to an army in the field is as important as that of the more material lines of communication. The telegraph, in fact, has become a necessity of the age. No war could now be undertaken without its aid.

But it is not only in annihilating space, and bringing within the mental view of the master mind a dozen armies and a million men, that telegraphy is so valuable; it is in the rapid communication of intelligence and orders to and from the Commanding Officers of each limb of each army, however small; it is in connecting together, in immediate communication, the different parts of a fortress or an entrenched camp, however much they may be scattered; it is in maintaining an uninterrupted connection between all parts of a besieging force, however extensive may be the lines of circumvallation, that it is so serviceable. It would have been impossible to have kept on the sieges of Paris and Metz without it. Indeed, it has a civilizing influence, for it not only tends to shorten the duration of war, but to diminish the loss of life, by rendering possible those combinations which, in the cases of Sedan as well as of Metz, swallowed up temporaily in prison two great armies. Moreover, it facilitates the supply of food, it

regulates the traffic on railways, it aids the transport home of the sick and wounded, it satisfies the craving for news, and it alleviates anxiety at home. It is well known that the Germans, guided by their experience of 1866, commenced the war of 1870 with a very well organized and extensive system of telegraphs for field service, but that the French had a system wanting in efficient organization and miserably deficient in men and material. We know little of the present Russian system, excepting the fact that by its aid the army around Plevna maintained its bear-like hug on the doomed fortress, and enabled it to thwart, with overpowering force, the tiger-like rush of Osman Pasha.

So important is efficient telegraphy now considered for the British Army that 6 officers and 160 men are being trained and maintained in efficiency in the British postal telegraph system, so as to be available in time of war. They are, in fact, daily rehearsing that part which they may have some day to perform in earnest in an enemy's country. Moreover, we have our field telegraphs in constant training at Aldershot, Chatham, and elsewhere, though it is very doubtful whether this department has been nearly sufficiently developed, or is anything like being properly equipped, for such an army as ours. However, I am here, not to criticise or describe the equipment of our military telegraphic system, but to describe an apparatus which may prove a most useful and valuable adjunct to the already well matured system of waggons and barrows and cables in actual use. I must draw a distinction between the permanent telegraphic system of the country occupied by an army, the semi-permanent lines of telegraphy which connect head-quarters, as it advances, with this system, and the "flying "line" or temporary system of field telegraphs which follows the movements of the various corps in the field, and maintains their communication with head-quarters. The first two must necessarily be worked on the ordinary telegraphic system in use, maintained by technical skilled labour, and worked by well trained, experienced telegraphists. The flying line need not necessarily be so manipulated. There is also the visual system, intended for outpost and reconnoitring duties, and which necessarily must be continued under circumstances which render field telegraphs impractical. I do not intend to refer to this admirable system.

At present, the apparatus in use for field telegraphy is the ordinary Morse recording apparatus, which records its messages in the ordinary dot and dash alphabet, understood only by the initiated, supplemented by a sounding instrument, which appeals, by a similar foreign language, to the ear. Thus, to convey intelligence from one point to another, a message has to be written down on paper, it has then to be translated by a telegrapher into the *Morse* language, which has to be re-translated at the distant end into the ordinary written language, and then read by the recipient. These operations are subject to error, and have not secured faith in their reliability. Is there any Commanding Officer here present who would not wish such an uncertain agent in a very warm place? Those who were present at the Autumn Manœuvres on Salisbury Plain know how to value its services. It is unquestionable

that the telegraph has not inspired confidence, and this is due as much to its natural uncertainty as to the want of knowledge of the tool that is used. Accuracy in the transmission of orders is the *sine quâ non* of a military telegraph. We know of one great disaster that arose from a mistake. "Some one has blundered." It was the very last thing determined upon in our late Ashantee War, and the rapidly collected materials drawn from the Post Office stores were dispatched at the last moment, by passenger train, and stowed in the officers' baggage room. Yet we have the authority of Sir Lintorn Simmons for saying that the operations in that war could not have been carried on as they were without its assistance, and that it was productive of very great economy to this country by shortening the expedition and enabling the greatest amount of benefit to be derived from the materials and means that were placed at the disposal of the General in command.

Now, the telephone, if it prove a practical instrument, will place in the hand of every officer an instrument which will transfer the actual words and tones of his own voice to his correspondent at any reasonable distance. I have spoken distinctly, at various distances up to ninety miles; last week I spoke from Holyhead with my friends in Dublin, through the cable joining those two places, and I have been able to recognise, with absolute certainty, the voices of different people at sixty-seven miles. It will solve the moot question as to the best form of instrument for military telegraphs, about which there is much diversity of opinion.

How is it that the human voice itself can be reproduced at such distances? When I strike a bell, blow a whistle, sound a reed, clap my hands, or speak to you, how is it that these different operations are conveyed through your ears so as to produce on the brain that sensation which is called *sound?* The air itself, in which we breathe and move and have our being, is a highly elastic medium, which readily receives and transmits any motion imparted to it. When I clap my hands, I suddenly throw this air into motion, a wave is formed, just like a stone thrown into water generates a wavn that circles round and round, striking and enveloping everything in its course. This air-wave likewise envelops everything in its course and impinging upon the tympana of your ears, it there affects the nerves in such a way as to convey to the brain that sensation which education has taught us to be that sound due to the clapping of hands. Sound is therefore simply the undulations of the air; but there is sound and sound. I shake this box of nails; it makes a most disagreeable noise. I blow this reed; it makes a soft musical tone. Why have we in the one case *noise* and in the other *music?* In the one case the waves follow each other in irregular spasmodic fashion, shivering the drum of the ear with unpleasant shocks; in the other case the waves follow each other regularly, periodically, and rythmically, blending together on the drum of the ear with pleasant sensations. Let us ignore noise, and confine ourselves to this musical instrument. I blow a note. If it were possible to illuminate a tube of air between the mouth of this instrument and any one of your ears, you would see this air chased and moulded into the most beautiful and regular undulations; not

rises and falls, like the vertical waves of the sea, but condensations and rarefactions—close order and open order—more like a field of barley in autumn time responding to the motion of a gentle breeze. If we conceive a line of particles to be arranged along this tube, like a long file of men or a row of marbles, then if each particle takes an excursion to and fro for the same distance (the same *amplitude*), however small, then if the motion of each particle be successive, and not simultaneous, the line will be excited into waves or sonorous vibrations, as shown in Fig. 1.

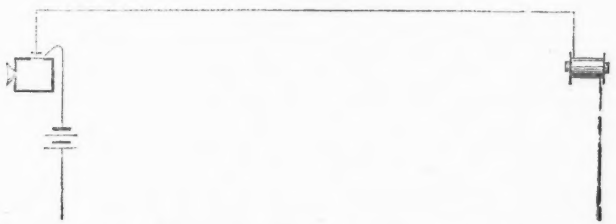
FIG. 1.

Now, let us fix our attention upon this musical instrument and this suppositious tube of air. I can produce various *notes*. One note differs from another note only in the number of waves or sonorous vibrations produced per second. Middle C of the piano makes 264 of these vibrations, E 330, F 352, A 440, and the octave to C 528 per second. The lowest note that can be heard by the human ear is 16 complete vibrations per second; the highest, 38,000. The range of the human voice is between 65 and 1,044 sonorous vibrations per second. Whenever and however we produce air vibrations, pursuing each other regularly between these two limits, we have *notes*. And one note differs from another note in its *pitch*, which is the number of its sonorous vibrations per second. But these notes may be soft and gentle or rough and loud. Hence notes differ, not only in their *pitch*, but they differ in their *loudness*. Loudness depends upon the energy of the source of sound and upon the amplitude of the consequent vibrations of the particles of air. If I blow gently, the excursion to and fro is small. If I blow fiercely, the excursion to and fro is great. The former undulations strike the ear gently, and the sensation is low; the latter strike it fiercely, and the sensation is loud. Again, I take three or four different instruments and I sound the same note on each with the same force. The pitch is the same, the loudness is the same, but there is no mistaking their difference. This difference is called their quality, clang-tint, or *timbre*. Now, what causes this clang-tint? I must beg your attention here, for here lies the secret of the new articulating telephone. This clang-tint is due to the *form* of the wave of air. It is very difficult to conceive a difference in the form of a wave of air. It is simple enough when we regard water. We see this for ourselves upon the surface of a pond or of the mighty deep. But the difference of an air-wave lies, not in its geometrical form so much as in the rate of motion of its different particles. I wave my hand backwards and forwards regularly or irregularly. I can make it move at any given rate, at any given time, and, though the number of excursions and the amplitude of excursion to and fro per unit of time may be the same, I can vary the form or rate of excursion at will. This produces difference of quality, and this is why

middle C, sounded on a piano, on a harp, on a bugle, or by the voice is the same note, but differing so much in clang-tint. It is impossible to picture in the mind the beauty and minuteness of the sound-waves. The ear, though approached by a channel the diameter of only a quill, will receive the vibrations from a hundred voices and instruments and can separate each by attention. Hence we arrive at our first proposition, that sound is due to the undulations of the air, and that, as these undulations vary in number per second, in amplitude, and in form, so we have noise or music, varying in pitch, in loudness, and in clang-tint.

We have now to consider how we can catch up, as it were, these sounds, and convey them into something else. It is said that Lablache could sound a note so deep and loud that he could crack a tumbler. Whenever anyone sings in a room, something can be always heard to rattle. If you open the piano, and sound the vowels on the middle notes, you will hear the piano repeat them. Hence we learn that the air vibrations can be imparted to other grosser matter in their path. I hold before my mouth this disc of parchment—a small drum-head. It responds to the tones of my voice. I can make this evident to you. It is so constructed that it makes and breaks an electric current every time it vibrates. This electric current operates as an electro-magnet. The electro-magnet actuates an armature. If the motions of this armature are of the same number as the disc, we shall have the note repeated. There you are. Every note I direct upon the disc is repeated by the magnet. But I cannot vary this note. Whether I shout or whether I hum; whether I sound the note upon an instrument or upon a tuning-fork, the note given out by the magnet is the same. It varies only in pitch, and not in loudness or in clang-tint. This is the first telephone ever made, that of Riess of Friedericksorff, and it is illustrated in Fig. 2.

FIG. 2.

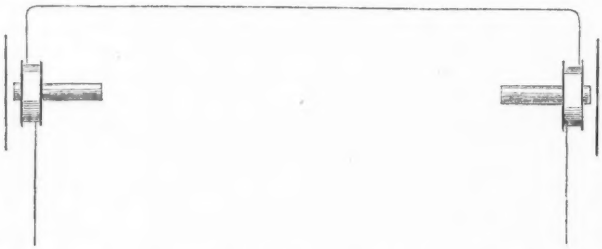


Now I must make a temporary diversion into the realms of electricity.

There are many ways of producing electricity. We have just used a battery where the electricity was produced by the chemical decomposition or combustion of zinc, just as heat is produced by the chemical decomposition or combustion of coal. We can produce it by friction or by heat, but one very common mode is to produce it by the motion of a coil of wire in the neighbourhood of a permanent magnet, or

vice versâ, by the motion of a magnet near a coil of wire. This is how an ordinary shocking coil is made. Here is a large permanent magnet and here is a coil of wire. I suddenly move that coil of wire, a current is produced, and I have rung a bell. But even if the magnet be fixed and the coil be fixed, any variation in the strength of the magnetism about that coil will produce a current of electricity in that coil. Thus if in front of that magnet which has a coil fixed on its pole, I move this mass of iron, a current will be produced in that

FIG. 3.



coil. And for every motion of that piece of iron I can produce a current of electricity. But more than that, the current will rise and fall in intensity exactly as the iron moves. Hence the currents of electricity produced in that coil will vary exactly as the motion of that mass of iron. Now suppose that mass of iron to be a thin disc like our parchment drum-head, but of iron; and I speak to that disc. We know that that disc will respond to my voice. Whatever words I sound, however I vary them in pitch and loudness and quality, that disc will vibrate in number, amplitude and form, exactly responsive, and currents of electricity will be produced in that coil which will vary exactly in number, strength, and form, with the words I utter. Let this coil be connected with an exactly similar coil at some distance off, and let the currents in the first coil circulate through the second, then if the second coil surround a mass of soft iron, these currents will induce magnetism in the soft iron, and the strength of this magnetism will vary exactly with the currents producing it. If in front of this iron coil we plant an iron disc exactly like the first one, then every time the iron coil is magnetised it will attract the iron disc, and will cause it to move. Now the motions of this disc will vary exactly with the variation of the magnetism of the coil. The magnetism of the coil will vary exactly with the strength of the currents producing it. The strength of the currents will vary exactly with the motions of the first disc, and hence the motions of the second disc will vary exactly with those of the first. In fact they will be an exact reproduction of the first. Hence with whatever note the first disc vibrates, however much it varies in pitch and loudness and quality, the second disc reproduces those vibrations exactly. Those vibrations are imparted to the air and thus we have sounds reproduced

with all the delicate variations of the human voice. The sound of the human voice is transmitted into electric currents, and these currents again produce sonorous vibrations which exactly reproduce the human voice. Indeed, there is no sound which the human lips can produce or the human ear can detect, which cannot be reproduced on the telephone, and where it not for practical difficulties, sounds that "mellow to sadness now madden to crime," could be as easily transmitted from the east to the west as from this hall to the room above. In fact, to "waft a sigh from Indus to the Pole," is removed from the poet's dreamland, and has become as much a matter of fact as "extracting sunbeams from cucumbers."

But not yet—the vapourings of imaginative newspaper correspondents are not yet practical. The articulating telephone itself is an extremely delicate apparatus. It is subject to interference by every waif and stray current that wanders into a telegraph wire, and their name is legion. Atmospheric electricity, earth currents and the influence of neighbouring wires, all generate these troublesome wanderers and interfere with its action. So that on existing lines of telegraph, except for short distances, it has not yet been found useful or even practical, but on short independent isolated lines like those used for field telegraphs, it is a thorough practical instrument, and well deserving the fullest trial that actual service can give it.

It works to perfection in mines. There it is not only free from all extraneous troubles, but the silence of the grave facilitates the operation of its "still small voice." It is not even necessary in such places to put it to the ear. Wherever, however, extraneous sounds intervene not only is it necessary to put it close to the ear, but to effectively shut out all disturbing elements, two telephones are used, one to each ear. A bi-aural stethoscope applied to it is also found an useful adjunct. By its means reading is very simple. How far it could be heard amidst the roar of artillery and the din of battle remains to be tried.

What it does is this: it transmits to a distance far beyond the reach of the ear, or of the eye, the words of command, the tones of voice, the distinct and unmistakable articulation of the general as well as of the private. Such an apparatus must be valuable for military purposes.

How far it can be utilized for naval purposes remains to be seen. Wherever a wire can extend there can the voice be sent. In communicating between the bridge and the wheel, between the turret and the engine room, between the look-out and the officer of the watch, it ought to be useful. For diving operations it is invaluable. In torpedo operations and range-finding it may prove useful.

But at present it is a mere child. It has startled us all by its novelty, its beauty, and its simplicity. Time alone is required to establish its utility. Probably no instrument that has ever been devised has created more sensation, or has attracted so much attention, and I feel highly honoured in having been allowed to bring before such a distinguished audience the incomparable invention of Alexander Graham Bell.

Major WEATHERHEAD: I should like to ask how it happens that the vibration

continues so much longer in the case of the bell being struck, than it does in the case of the sound of the voice?

Mr. PREECE: The simple reason is, the vibrations of the bell are continuous if they are not rapidly stopped. When I take a whistle, blow it and stop, the sound ceases at once the moment you remove the source of the sound. But in the case of the bell, as in the case of the glass, the vibration continues. If you cause a finger glass to sound, you can see the musical wavelets on the surface of the water, which very prettily show the vibration of the body itself. There is a loss of power in the telephone however at a great distance; as the distance increases it has just the same effect as it would have upon the voice itself, for when a person speaks further and further away, the sounds come gentler and gentler; and in the telephone when you add resistance or increase the length of your line, so the voice seems to come from a greater and greater distance.

Captain MAYNE, R.N.: I should like to ask you how far the voice will go, and whether you have any idea of being able to communicate in this way across the Atlantic?

Mr. PREECE: I am not prepared to say that there is much hope of our talking across the Atlantic, but I think it possible to talk to distances greater than the distance across the Atlantic. The reason we cannot talk across the Atlantic is because there is a peculiar electric effect in submarine cable called induction; it is as though the electricity were absorbed by the gutta-percha, and small currents sent in at one end never arrive at the other. They get rolled up as it were into one, so that on a long submarine cable, instead of getting the finer sounds when the vibrations are rapid, they would all come out as one current, not producing any sound at all. It does not seem at present practicable to apply to a greater distance than 200 miles, but in the present day that man would be a very rash man who would affirm that it is impossible to do anything.

The CHAIRMAN: We must, I think, thank Mr. Preece very much for the interesting and able lecture that he has given us on the Telephone. There are probably few gentlemen who have had greater experience in telegraphy than Mr. Preece, who is a member of that department to which we all owe so much—the Postal Telegraph Department. I think that none will deny the great advantages of the telegraph, and there are few Officers who are not well aware of its great importance in the Army on service. I can hardly speak so much of the Navy, but I dare say that there the telegraph will also be of great use. There is no doubt that in all the cases that have been mentioned by Mr. Preece, it will be most valuable. There is one thing that I think will bear much on its advantages in the Army, viz., that it will do away with a great deal of difficulty in providing a sufficient number of telegraphers on service. Here every man will be as it were a trained telegrapher; a General will be able to speak through the telephone without having received any instruction in telegraphy. It only remains for scientific gentlemen to perfect this instrument, which can only as yet be considered as in its infancy. There lies the great labour, we must try experiments and endeavour to perfect it as soon as we can, and I am quite sure that the result will be to the great advantage of our services. In your name I beg to thank Mr. Preece for his interesting lecture.

NAMES OF MEMBERS who joined the Institution between the 1st January and 31st March, 1878.

LIFE MEMBERS.

Travers, J. A., Capt. York Art. Militia.
Pochin, Norman, Lieut. 7th Royal Fusiliers.
Poole, M. C., Capt. Madras S. Corps.
Maule, H. B., Major R.A.
Hay, James B., Lieut. R.N.
Smith, Walter W. M., Lieut. R.A.
Barrett, Lennard, Lieut. R.A.
A'Court, Charles, Lieut. Rifle Brigade.
Cowan, Jas. H., Lieut. R.E.
Draffen, W. Pitt, Major Westmoreland Militia.
Tomlinson, E. D., M.D., Surgeon-Major A.M.D.
Cooper, Wm., Capt. Liverpool Rifle Brigade.
Whitehead, Henry, Lieut. 8th Lanc. Rifle Vols.
Gordon, Alexander, Capt. 3rd Middx. Art. Vols.

ANNUAL SUBSCRIBERS.

Rolph, W. M., Capt. 17th Regt.
Spicer, W. J., Ens. Hon. Art. Company.
Gordon, W. L. C., Lieut. R.A.
Montgomery, Sir Robt., G.C.S.I., K.C.B.
Ross of Bladensberg, E., Lieut. R.E.
Florence, Henry L., Capt. 40th Middx. Rifle Vols.
Dickson, E. T., Lieut. 49th Regt.
Wavell, L., Major Ben. S. Corps.
Hudleston, Wilfred, Lieut.-Col. Madras S. Corps.
Butler, John, Major 3rd Surrey Rifle Vols.
O'Brien, E. D. J., Lieut. West Kent Militia.
Crowe, Robt., Capt. h.-p., Unatt.
Paton, Geo., M.D., D.-I.-Gen. of Hospitals.
Vallings, A., Capt. Ben. S. Corps.
Hirst, T. B., Capt. 34th West York Rifle Vols.
Lawton, F. E. A., Lieut. 34th West York Rifle Vols.
Prichard, H. C., Lieut 2nd Lon. Rifle Vols.
Tyrwhitt, Philip N., Commander R.N.
Drew, George, Lieut.-Col. 1st Lon. Engineer Vols.
Skene, J. G., Major 77th Regt.
Jones, E. V., Capt. 28th Middx. Rifle Vols.
Wilkin, W. H., Major 3rd Middx. Art. Vols.
Heath, W. E., Capt. 39th Middx. Rifle Vols.
Phillpotts, A. T., Lieut.-Gen. R.A.
Egerton, G. Le C., Lieut. R.N
Beresford-Peirse, A. de la P., Lieut. 25th Regt.
McMinn, F. A., Capt. 2nd Middx. Art. Vols.
Lee, Henry, Capt. 3rd Shropshire Rifle Vols.
Garstang, T. W. H., Capt. 19th Middx. Rifle Vols.
Styles, R. Osman, Lieut. 19th Middx. Rifle Vols.
Freeland, John, Capt. 2nd Surrey Rifle Vols.
Robinson, W. M., Lieut.-Col. 2nd Surrey Rifle Vols.
De Hodgson, D. F., M.D., Surgeon-Major A.M.D.
King, Walter S., Lieut. R.N.
Pitman, William, Capt. R.M.A.
Masterman, John, Lieut. R.N.
Parkinson, R. H., Lieut. 33rd Regt.
Gladstone, C. E., Lieut. R.N.
Grey, Harry G., Lieut. R.N.
Cheyne, W. R., Capt. 4th Middx. Rifle Vols.
Rolfe, Robt., Capt. 39th Middx. Rifle Vols.
Colomb, Geo. H., Col. R.A., F.S.A.
Barnett, H. C. B., Lieut.-Col. Madras S. Corps.

Kingscote, Anthony, Lieut. R.N.
Torry, H. J. B., Lieut. Royal Lon. Militia.
Fitzgerald, C. J. O., Major Madras S. Corps.
Philipps, C. E. G., Lieut. Pembroke Yeo. Cav.
Lee, Ellis, Capt. 65th Regt.
Creswick, Nath., Lieut.-Col. 4th West York Art. Vols.
Lambert, Geo., Lieut. 22nd Middx. Rifle Vols.
Lambert, H. C., Lieut. 22nd Middx. Rifle Vols.
Hutton, Herbert, Capt. 4th West York Art. Vols.
Wire, Travers B., Capt. 1st Surrey Rifle Vols.
Fergusson, J. A., Lieut. Rifle Brigade.
Vaughan, Henry, Commander R.N.
Silk, C. Alex., Lieut. 1st Kent Art. Vols.
Fryer, G. W. S., Lieut. 1st Warwick Militia.
Wadmore, A. H. T., Capt. 11th Middx. Rifle Vols.
Monckton, E. P., Capt. Northam and Rutland Militia.
Andrew, C. W., Capt. late 19th Surrey Rifle Vols.
Custance, R. N., Lieut. R.N.
Rason, E. G., Lieut. R.N.
Sandes, H. T. T., Capt. R.A.
Cole, W. U., Lieut. 3rd Dragoon Guards.
Woodman, L. J., Capt. 3rd Lon. Rifle Vols.
Gambier, J. W., Commander R.N.
Holland, G. E., Lieut. Lon. Rifle Brigade.
Kinder, Ernest, Lieut. R.N.
Hill, F. C., Lieut.-Col. 56th Regt.
Pott, Norbury, Major 1st Surrey Rifle Vols.
Colvile, F. M., C.B., Col. 21st Brigade Depôt.
Fellowes, James, Capt. R.E.
O'Neil, Geo. A., Lieut. 8th Lanc. Rifle Vols.
Welch, F., Capt. 25th Regt.
Bray, Norman A., Lieut. 27th Regt.
Cleather, W. B. G., Major 47th Regt.
Helme, G. C., Capt. 10th Regt.
Ford, William W., Lieut. 23rd Middx. Rifle Vols.
Kerby, William, Lieut. 7th Cornwall Rifle Vols.
Purchas, J. R. P., Lieut. 40th Regt.
Long, C. J., Lieut. R.H.A.
Bell, R., Lieut. 56th Regt.
McClintock, W. G. W., Lieut. 19th Regt.
Hills, John, Lieut.-Col. R.E.
Bushby, J. William, Lieut.-Col. Queen's Westminster Rifle Vols.
Pocklington - Coltman, R., Major 1st Middx. Engineer Vols.
Stephens, J. N., Lieut. 1st Surrey Art. Vols.

OCCASIONAL PAPERS, NOTES,

AND

NOTICES OF BOOKS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

It is requested that communications, or books for review, may be addressed to

LIEUT.-COLONEL LONSDALE A. HALE,
Royal Engineers,
Royal United Service Institution,
Whitehall Yard, London, S.W.

NON-COMMISSIONED OFFICERS IN CONTINENTAL ARMIES.

By John Ross of Bladensberg, Coldstream Guards.

The question of obtaining a good class of non-commissioned officer, is one which is occupying the serious attention of most Continental nations. Men for service in the ranks are obtained easily enough, and so as a rule are Officers, but the grade connecting the two is wanting. Governments can indeed afford to be very careful in selecting their Officers; and considering how much of the success in war depends upon them, too much attention can hardly be given to seeing that those on whom commissions are bestowed are in every way worthy of their position. Ambition, the desire to embrace a manly career full of enterprise and popular in society, make many wish to become Officers, but not so non-commissioned officers. Their position has little attached to it to make it attractive; it is subordinate, and the honourable discharge of its duties is rewarded, rather by a bare sense of satisfaction than by any more substantial recompense. After a long service, perhaps spent in night work, in bad climates, or even campaigns, a man often finds himself impoverished, broken in health, and unable to take his place among those neighbours who devoted themselves to walks in civil life.

The presence of a good subordinate class of officials is a necessity for all armies, but it is so now more than ever. Modern Continental armies are not what they used to be; now they are regular depôts for an extended and national war organization, through which large batches of recruits have to pass, and where a continual instruction and drill converts the peasant into a soldier. Tactics also as developed in the last few years have imposed new responsibilities upon the non-commissioned officer; there is a greater necessity for individual action and intelligence than formerly, and in the late Franco-Prussian War there were even cases in which sergeants were temporarily vested—at critical moments—with small commands owing to the death of their Officers. To fulfil these new duties, the good old type as personified abroad in the Prussian corporal of Frederick the Great hardly exists, and is dying out rapidly; and there is a great difficulty to be found in inducing the middle classes of society to embrace a military career, or, at all events, to devote some time beyond the obligatory term in the service of the country. The increase of manufacturing energy and commercial enterprise is the principal cause which keeps away this class, which would be so useful as non-commissioned officers; they

can get high wages and live in affluent circumstances in civil life, why should they then put up with the chequered life of a soldier? In the Rhenish and Westphalian provinces it was found more difficult to retain the services of men quartered there, than in the Eastern districts of the German Empire, and for the same reason; high wages were to be found in the former, but not so readily in the latter. The plan of universal service now adopted abroad has also, in a great measure, increased the difficulty. That plan gives powerful armies and large reserves; soldiers exclusively so by profession are discarded, but the whole male population is trained to arms, and every man must pay a tax in personal service before he is permitted to devote himself to his profession or occupation in life. The short training is sufficient to mould the masses into soldiers, but not so to form good non-commissioned officers; also they are too young and inexperienced, and there is quite enough to do in the regiments, to attend to the recruits which constantly arrive. In former days when *long* service was the rule, those who entered the Army knew that a large portion of their life would be spent under the colours; the smartest of them would naturally seek to gain the top of their profession, and try for the highest pay and best pensions. But not so in compulsory service for *short* periods; there they will get it over as soon as possible, and, burying themselves in their civil pursuits, try and forget all about military life.

If the Government could enlarge its expenses and compete in the labour market, there can be no doubt that it could obtain the services of the best men of the country for non-commissioned officers. But it must be remembered that every nation is oppressed with a load already well nigh insupportable, owing to its bloated armaments. Few could spend anything more, and thus each seeks to solve the question, by other means than that of inflicting an additional and weighty tax upon the people; economy, very rigid economy, is the only basis on which they can act.

One of the chief means of obtaining the necessary quality of men for non-commissioned officers in modern armies, is the creation of special schools or corps of instruction. Germany and Italy, as will be seen, have adopted this plan very largely. The best place very naturally in which to train young men who hope for promotion, is in the ranks. It is there that they learn to appreciate the feelings of the men, and are taught to respect the traditions of their corps, and the customs of the service; it is there that their characters are studied by their superiors, and the degree of advancement they are fit for ascertained; and it is there they gain instruction, experience, and tact, which are all so absolutely necessary. But as there is a difficulty in this, in modern armies—if the men will not re-engage after their obligatory service—a more rapid mode of training has been adopted by these schools. There are, however, some drawbacks to the system; the men who issue from instruction as sergeants are too young, younger often and perhaps inferior in attainments to many of those whom they are placed over. They will always form a different *caste* to the rest of the Army, and have little in common with the rank and

file, of whose prejudices they must necessarily be ignorant. There will, it is true, be a leaven of older and re-engaged sergeants who will give their tone to their juniors, and prevent them from abusing the power which they have got so easily; but this will not compensate for the disadvantages of the system. It must be remembered also that schools for training non-commissioned officers are very costly to the State, and especially so when, as in Germany, it is found necessary to establish a preparatory school. Thus the country pays for the education of men who are to fill quite subordinate posts, during which time they are maintained at the public expense, although they perform no military service.

The best means of securing good non-commissioned officers is to induce them to re-engage. This is mainly done by giving them extra pay during their re-engaged service, and a bounty or pension at the end of a certain time, together with the prospect of a situation in the civil service of the country. It has been found that to ensure a comfortable future to a man is the best means of inducing him to remain on after his first term of service; and a question arises of some importance, whether it is advisable to do this by granting places in railways, telegraphs, post, and other offices. Old soldiers with habits of discipline, order, and regularity, are very likely to discharge their new duties very well, but it is evident if they are the only class in the community who are to get these posts, a very important part of the national wealth is unduly burdened. Although they may be well educated they may not suit the place, and if they get it by right rather than merit, they have not the same reason to try and please their employers. The numerous decrees also issued to secure situations for old soldiers, lead to the belief, indeed, that if an open competition were to be allowed, and the best men only chosen, the non-commissioned officers would not by any means always get them. On the other hand, the inducement held out by the hope of civil employment is not considered sufficient to keep men in the ranks after their obligatory service. According to reports from France, the small number of old non-commissioned officers proposed for civil posts, is held to prove conclusively the mistake in thinking that this means alone will keep them under the colours. There are also some in Germany, where as will be seen this system is most relied upon, who consider that it is unwise, and unduly taxes the civil administration of the country, and they believe that a sum of money should be given instead.

But how is this money to be raised? In Italy a special fund is set apart for the payment of these bounties, and the principle adopted appears to have great advantages. It is based on this:—military duty is obligatory to all, but some do not serve, either they cannot from weakness or other causes, or they enter the ranks as one-year volunteers; these then are taxed, and can be made to pay a fine instead. The money so acquired is devoted to the non-commissioned officers' fund. In Italy, it will be seen, the fines paid by one-year volunteers are applicable to this purpose; also in Austria money is obtained, as will appear, from the interest derived from funds, obtained from those who did not serve the State in personal service; but nowhere

else is the principle even in force at present. In France a few proposals to that effect have been made, but the desire to abolish one-year volunteers and the fear that exemptions may again be obtained by money, will probably prevent them from being even considered. Some such system was in force in Bavaria for a short time before the late war; old non-commissioned officers received a bounty of 800 gulden (£66 13*s.* 4*d.*), which was paid out of a fund supplied by the fines (called *wehrgeld*) of those incapable of serving, and which varied from 3 to 100 gulden (5*s.* to £8 6*s.* 6*d.*). This was abolished in 1871, the Germans considering that in some way it might let in the thin edge of the wedge, and end in monetary payments for substitutes.

There are a number of men who, from physical infirmity or other causes, are unable to serve at all; there are also those, who, although liable and able to serve, get off on account of the contingent being strong enough without them; and it would seem but fair that they should pay in purse that which they cannot pay in person. Some men, of course, are afflicted by nature to such an extent, that they are burdens on their families; but there are others who, from slight weakness or even tardy growth, cannot bear the fatigue of a soldier's life, but who can easily earn a livelihood. The former should naturally not be taxed; but the latter by paying no fine, get off at present scot free, and benefit immensely by their contemporaries being in the ranks; because they have the field to themselves and get a three years' start of them. These should be made to pay the *wehrgeld*. It may be objected that for the country to pay annually a sum of money which is not levied at the time by Parliamentary vote, is a principle entirely foreign to our ideas; doubtless it is so, and so ought it also to be in all constitutional nations. But, is not universal and compulsory service, the very essence of a tax raised without the sanction of Parliament? If most have to pay their dues to the State in kind, by giving up the fruit of their labour and the value of their time, why should the remainder come off scot free, and shield themselves from loss behind a constitutional principle already broken? In Germany, as we have said, other reasons have abolished the *wehrgeld*, but these might be got over; of course, care should be taken not to permit able-bodied men to get off their term of service by payment of money, and a system of checks could be arranged for this purpose. The idea of substitutes for military duty for a sum of money is not entirely foreign to the Prussian organization; one-year volunteers is only another form of it. This institution is doubtless a necessary one, but its presence shows that the military laws of even Germany have to bend to circumstances; and it may be, that a judicious application of the *wehrgeld* system could form a fund which is so important for the reward of non-commissioned officers, who have served a certain number of years in the Army. If the *wehrgeld* were established throughout the German Empire, it would be the means, it is calculated, of procuring three to four million *thalers* (£450,000 to £600,000) annually, and this would be ample to supply all necessities.

The *Bulletin de la Réunion des Officiers* has published last year some

remarks from the *Allgemeine Militaire Zeitung*, advocating a military tax in the German Empire, for the benefit of the non-commissioned officers. This is a species of poll-tax to be raised on all young men reaching the age of twenty. The following is the calculation given if it were imposed:—at twenty marks (£1) per head, and with 540,000 contributors, a yearly sum of about 10,500,000 marks are obtained. The German Army has about 48,000 non-commissioned officers, and if a third of this number re-engage and receive 300 marks per annum as extra pay, a little less than 5,000,000 marks are spent. The remainder is then in hand for the relief of those widows or orphans who have lost their relations in war time.

An important part of the question under consideration remains to be examined—promotion from the ranks. France has specially adopted this system, being probably impelled thereto by her republican notions. The *corps* of Officers in that country is recruited, first, from students at military colleges, and, secondly, from non-commissioned officers. The latter formed about one-third of the whole, and rarely attained the lowest grade in their new sphere before the age of thirty. As a rule they were good and efficient non-commissioned officers, but thoroughly unfit in education or in general attainments to form a good body of Officers, for without early training they could not become efficient commanders. These promotions then split up the *corps* of Officers into two distinct classes, and destroyed that union and equality which is so essential. Added to this, however, those who came from the ranks, being unfit for promotion to the higher grades—very few sergeants would make efficient Generals or even Colonels—were passed over by their younger and more intelligent companions from the military colleges, and all the best positions in the Army were filled by these latter. The others then found themselves neglected, and superseded by juniors, who, apparently, were on the same footing as themselves. Nor was this all, for so great an influx of men belonging to the lower and middle classes of society, into the body of Officers, militated against the social position of the whole *corps;* rendering commissions unpopular to those who from birth, antecedents, and education would make the best, the most intelligent, and most devoted leaders of the Army. Such was the organization which broke down so signally in 1870, and such it remains still, with the exception that the self-sacrificing efforts of every one in France will go far to remedy any defect in this system. An attempt has now been made to educate those non-commissioned officers destined for promotion; and this plan has been adopted in Italy, where no sergeant can be raised to the "*epaulettes*," without going through the school set apart for the purpose; this is also the case for the infantry in France. But to adopt this plan, in order to obtain *a reward* for non-commissioned officers, is a mistake, it being open to precisely the same defects as already related. Again, men who have passed years in an inferior position will often regard their elevation not so much as a starting point to future work and advancement, but as the end of their ambition; their new duties will then be discharged rather with indifference than with zeal. In fact, promotion from the ranks sacrifices the

welfare of the *corps* of Officers, in the hope of benefiting that of the non-commissioned officers—a system which is altogether suicidal.

On examination, however, it will be found that neither does the plan benefit that class which it is meant to reward. Their position is not fixed but transitory and unstable. The general desire is to gain a commission, and those that fail in their object—all cannot succeed—have missed their vocation in life, and are consequently humiliated and weary of their profession; there will then be a large leaven of disappointed non-commissioned officers, certainly no advantage to the service. Some in France consider that either too many or too few commissions are given; it is not the prize of the specially deserving nor the lot of all sergeants; they compare this state of things with that in the French Navy, where promotion from the ranks is unknown. Petty officers of the fleet are said to be far better men and more contented than their equals in the sister service; they have gained a real position in life, in which an honourable career is to be found, and they do not crave after an ambition which most cannot reach, and failing which discourages and incapacitates them from further energy. In fact, "*l'homme préfère être le premier dans une bicoque que le second à Rome.*"

At best, a commission is but a doubtful reward to a man brought up to a different state of society, and the Germans, with more wisdom, have instituted quite a different state of things. The idea of promoting non-commissioned officers for the sake of inducing a good class of men to serve as such, is considered entirely wrong. The *corps* of Officers must not be injured; its *rôle* is all-important, and to carry it out we must have a carefully-trained and high-spirited class of men, able to direct with judgment and to lead with energy. It is, of course, understood that there can be no objection, nay, it is an advantage, when men show themselves competent to raise themselves from a subordinate position to one of trust and honour; the door can never be irrevocably shut which separates one rank of the Army from another. But men should never be so elevated until they are worthy of it; and to be worthy of it, more, far more, is required than the mere humdrum of respectable service. The rank of an Officer should be a high privilege and a position demanding the most exalted characteristics; this rank cannot be within the reach of any proportion of those that enlist; and to affirm that it is possible to allow a commission to be the reward of every respectable or averagely clever non-commissioned officer, is the same thing as to say that every solicitor's clerk, who can copy legibly and behave decently, should obtain the highest position in the legal profession. Life is composed of different orders, and each have their duties; a man born to one may perhaps be eminently fitted to another above him, but it is quite another thing to ignore these orders in the world, and to pretend that they do not exist; it degrades the highest honours of a country and brings no satisfaction to the men themselves thus unduly exalted.

In turning now to the regulations in force in some of the military Powers of Europe, it will be seen how each has endeavoured to procure good non-commissioned officers for its Army. Happily in

England the supply of these has not yet become a serious question. But taking into consideration the troubles of other nations, as well as the commercial peculiarities of this country, it is highly probable that if ever we should attempt to convert our people forcibly into armed masses, a great difficulty would be the question of how to procure non-commissioned officers.

Germany.

Non-commissioned officers in Germany are obtained from three sources:

1. From *gefreite* (answering to our lance corporals) and privates, men of good character, who know their duty, who can read, write, and reckon, and who have re-engaged (*capitulaten*). These, besides being practically trained, are taught in the regimental schools during the winter months, three to five times a-week, arithmetic, writing, grammar, elementary geography, and history. An Officer presides over this instruction; the students also do not get off any duty while undergoing the course. In the artillery the non-commissioned officers are principally drawn from this class, and especially from three-years volunteers. Candidates, after a year's service, and after passing a written examination, are appointed *obergefreite* (bombardier); three per battery are afterwards sent to the school of the regiment to undergo a course of instruction, which lasts from 1st October to the end of April, and which includes artillery, mathematics, interior economy, writing, and veterinary science. On terminating this course satisfactorily, the *obergefreite* receives a certificate, which qualifies him for the grade of corporal, and after another year's service, and another written examination, he is appointed as such, as a vacancy occurs. To rise higher, he must undergo a stiffer examination.

2. From men of good conduct who have not yet completed their obligatory term in the ranks, and who do not wish to re-engage. Compulsory service in Germany is very short; nominally three years, it often scarcely exceeds two years and a-half, and in the case of the smartest men who obtain the King's leave (*Köenigs Urlaub*), and who have passed their drills satisfactorily, it is not more than two years. The number of these latter is about twenty per company annually. It is consequently not easy for the military authorities to form their non-commissioned officers with the yearly contingent, and the cases where privates are promoted, who do not re-engage, are exceptions, only resorted to where men are likely to be of use, and where no others are available, which is sometimes the case in some regiments quartered in uncomfortable places. Out of 29,159 non-commissioned officers of the German Army in 1875, 2,414 belonged to this class.

3. From non-commissioned officers' schools.

Germany was the first to found schools for the education of non-commissioned officers. They grew out of an institution established from philanthropic motives in Potsdam in 1824, for the purpose of bringing up orphans of soldiers to a military career. After four years at the school, the boys were sent to the Instructional battalion, and

attached as a special division; and three years later they joined the army, with the rank of corporal. The General in command of the Guard Corps had superior control over this school, and the subjects taught therein were made to embrace everything necessary to form a good non-commissioned officer; in fact, the boys were destined to serve in that capacity; all attempts made to elevate the institution into a Cadet College for Officers were checked, and finally prevented by a Cabinet Order dated March, 1839. This school having been found of public advantage was increased; in 1831 it was doubled; in 1846 it became three companies strong, and in 1858, four companies, or one battalion. In 1860 a new school was erected at Juliers, copied from that of Potsdam; and in 1864, additions were made to the staff of each. In 1867 a third school was founded at Biebrich; two years later a fourth at Weissenfels; again, in 1871, the Imperial sanction was given to a fifth at Ettlingen, which had already existed for the Baden Army; and lastly, in 1873, a sixth was established at Marienwerder in Saxony. These have, therefore, now become quite a national institution, and in 1872 an Officer, with the rank of Major-General, was appointed to inspect and control them. They are each under the command of a Field Officer, or a Captain of standing, as Commandant, and they muster some 500 students each, together with a staff of Officers and non-commissioned officers. In order to insure a good class of the latter, to instil proper ideas of military discipline into the minds of the students, advantages are given to them in extra pay and increased chances of promotion.

Candidates for admission must be over 17 (14 in Saxony), and under 20; they must have a certificate of good character, and pass a simple examination in reading, writing, and arithmetic (as far as the first four elementary rules). On admittance, they must enter upon an agreement, by which they engage to remain in the Service their legal time (3 years), and besides a term of years, equal to double the period they spend in the school. This period varies from two to three years, according to the capability of the pupil, and counts as military service. Thus the State ensures that each man so educated will remain efficient in the ranks as a non-commissioned officer, for five or six years; latterly, it appears it has been reduced to four years. The instruction given is practical rather than theoretical, and aims at making the aspirant able to teach all that is necessary, as well as to set an example of military smartness—writing, reading, arithmetic, elementary history and geography, German, writing small military reports, sketching, and singing, are also taught. Good characters receive four weeks' holidays per year, their journeys home and back being paid for them.

When fit to pass out of these schools the students are posted to their regiments, their distribution being so arranged that those Corps who have sent non-commissioned officers to the staff of the school shall receive, if possible, three from the school in place of each sent there as instructors; otherwise the ordinary vacancies are filled up, the wish of any one for a particular regiment being taken into consideration as much as possible; thirty of the best go annually to the Guard. If

specially recommended they are made corporals six months before leaving the school; at the end of their term of instruction on joining the ranks all receive the bounty given to re-engaged men.

Last year another step has been taken in the education of non-commissioned officers of the German Army. It has been found that the schools have not altogether succeeded; the Government has called for individual reports on each man obtained from them, and the result appears to be that while they are considered satisfactory in military attainments, their moral characters are very bad. In fact it seems that the class of men required has not yet been got hold of. Good-for-nothing lads, whose parents are glad to get rid of them, present themselves in plenty; and thus, while the schools are full of such characters, the right stamp of men do not apply for admittance. It is very probable that this has prevented a greater development of these schools from being carried out. Another attempt is, however, being made to rectify these defects. It is found that the middle classes place their sons in business at about 15, and that good material is thus lost (the earliest age of admittance in the non-commissioned officers' schools being 17). A preparatory non-commissioned officers' school has therefore just been opened at Weilburg for the purpose of feeding the others, and the class of boys to be so obtained, together with the really good stuff already procured—sons of old non-commissioned officers—will, it is hoped, produce the elements required in the Army.

Candidates for this preparatory school must be over fifteen and under sixteen; they must have an irreproachable conduct, perfect health, know how to write legibly, read print, and understand the first four elementary rules of arithmetic. They must present a written consent of their father or guardian to the step they are taking; and must engage in writing to enter the non-commissioned officers' school on completion of the preparatory course, by which they agree to serve in the ranks four years, *i.e.*, two years for every one in the elementary school. The boys are not soldiers nor under the military code until they enter the non-commissioned officers' school, but they can only get out of their engagement by paying their expenses, which amount to 465 marks (about £23) per year. The course lasts two years, the Government pays for everything, feeding, clothing, lodging, and education; anything of a technically military nature is not taught, but all which tends to invigorate the body, gymnastics, fencing, swimming, &c., is specially attended to. Pupils from this school remain another two years at the higher school, or less if they are fit for it physically and in education; they then enter the ranks as corporals.

There were many applications for admittance into this institution at Weilburg, and many had to be refused, and it is probable if it succeeds that others like it will be established; this year from 100 to 150 boys are admitted, next year it is hoped that the full complement of 250 can be lodged.

These arrangements only secure the services of a man for a short time (four years) with the colours, which is not enough; the sergeants would be too young and inexperienced, and little likely to be of much

benefit to the service. An old and steady element is therefore absolutely required. The Germans, as all other nations, have consequently set a high value upon re-engagements, and have tried to induce men to remain on in the service. These re-engagements are made for one year at a time, with the consent of the Captain of the company, squadron, or battery. By this means a man can leave if he wishes to do so, without being tied to serve for a number of years, while, should his conduct not be considered satisfactory, the Commanding Officer may get rid of him easily. The fear of this will keep a man who has once re-engaged attentive to his duties, because unless he serves a certain number of years, he will not have a right to the advantages which the regulations hold out, and which induced him to embrace a military career. These rewards are principally given by appointments to civil posts, rather than by pensions or bounties; in fact, the Germans wish to make the rank of a non-commissioned officer the necessary stepping-stone to employment in the different civil appointments of the country.

As far back as 1867 it was decreed that non-commissioned officers, after twelve years' service, might obtain civil posts (if fit for it) in the following order: (1) those invalided, preference being given to those who are wounded or decorated, (2) those "half-invalided" or fit for garrison duty only, and (3) those who have retained their health and strength. As long as there are military candidates for these situations, civilians were to be debarred from competition.

In 1873 new advantages were conferred on non-commissioned officers:—

(1.) Their pay was increased, in some instances 30 and even 50 per cent.

(2.) Two new ranks were created, that of *vice-feldwebel*, or a junior sergeant-major, one per company, and usually given to an old sergeant as a reward after fifteen years' service. It has no responsibilities, and the pay is 3 thalers (9*s*.) a month higher than that of sergeant. The other is a new pay-clerk per battalion, a post of trust which enables a man to rise to Paymaster (*Zahlmeister*).

(3.) Their allowances and barrack comforts were increased, sergeants' messes started, and certain other privileges and considerations were extended to them, amongst others the obligation on the part of the soldier to address them by the title *Herr* (Sir).

Next year other regulations were issued (April, 1874). By these pensions were conferred; which were divided into five classes, viz.:—

	Sergeant-major.	Sergeant.	Corporal.
1st class per month	14 thalers ..	12 thalers ..	11 thalers
2nd „ „	11 „ ..	9 „ ..	8 „
3rd „ „	9 „ ..	7 „ ..	6 „
4th „ „	7 „ ..	5 „ ..	4 „
5th „ „	5 „ ..	4 „ ..	3 „

Non-commissioned officers are entitled (if not invalided) to a 1st class pension after 36 years' service, 2nd class after 30 years' service, 3rd class after 24 years' service, and 4th class after 18 years' service. The above are not paid if the pensioner ceases to be a German subject, or

if he receives a civil post worth a certain sum. It is considered that a sergeant-major should at least have a salary of 350 thalers (about £52), and a sergeant or corporal 250 thalers (about £37) a year; and if the situation does not amount to this, the difference is made up to him, out of the pension he would have got, had he not had the post. Moreover, pensions are given according to the rank held, only when the man has possessed it for twelve years; otherwise (unless invalided for wounds, &c., received in the country's service) according to the rank immediately inferior to it.

Invalid non-commissioned officers are divided into those that become so from natural causes, and those that are injured on service. If the former, the following are the pensions to be obtained:—

(1.) A 1st class pension after 25 years' service, if unable to live without the assistance of strangers.

(2.) A 2nd class pension after 20 years' service, if unable to earn a livelihood.

(3.) A 3rd class pension after 15 years' service, if nearly incapable of earning a livelihood.

(4.) A 4th class pension after 12 years' service, if partially incapable of earning a livelihood.

(5.) And a 5th class pension after 8 years' service, if able to gain a livelihood.

If the latter, then the following:—

(1.) A 1st class pension is given for any service, long or short, if the man is unable to live without the assistance of strangers.

(2.) A 2nd class pension when incapable of earning a livelihood.

(3.) A 3rd class pension when nearly incapable.

(4.) A 4th class pension when partially incapable.

(5.) A 5th class pension when able to gain a living.

In all these cases certificates to obtain civil posts are given should the man be of a sufficiently good character, and in many of the above certain additions are made for good service.

These additions are given:—

(1.) If entirely invalided in war, 2 thalers per month.

(2.) For each mutilation, loss of a limb, or other serious injury, 6 thalers per month. The total not to exceed 12 thalers (loss of sight is, however, considered as extra, 6 thalers for each eye blinded).

(3.) When completely invalided after 18 years' service.

(4.) To those unable to make any use of their certificates to obtain employments in civil life, owing to injuries received in the service, 3 thalers monthly, in lieu of such certificate.

It may be remarked that the Germans also give facilities to sergeants to marry, provided they place 100 thalers in the Savings Bank of their corps, for which they obtain interest. Quarters are given when it is possible to do so, and a certain sum of money is put by, for the education of their sons. Also a pension to the widow and orphans of those killed in war, or who die afterwards from their wounds.

The employments offered to non-commissioned officers of the necessary qualifications, were at first confined to the State railways, telegraphs, post offices, and everything under the Government; but this arrange-

ment does not seem to have answered its purpose sufficiently well, nor to offer a substantial inducement to men to remain their twelve years in the Army. It is calculated that there were some 34,000 places open to soldiers, but that they were not all filled; the pay attached to many of them was a small and insufficient reward, and thus it was found that the number of re-engagements diminished every year. The regulations of 1874 had the effect of only slightly increasing the number of those who meant to serve for their twelve years, but it augmented by 15 per cent. the quantity of those who remained on for a pension *after* their 12th year. Now this was not exactly what the Government desired, as civil posts and not pensions or bounties are the rewards it lays out for its non-commissioned officers. Accordingly a project was brought in March, 1877, before the Federal Council, by the Chancellor of the Empire, by which employment in private railways shall by law be given to soldiers having the necessary certificates, and who are at least thirty-five years old, and healthy in body and mind, in preference to others. The project continues, that these military candidates shall not be subjected to severer tests than others in considering their fitness, and if they have to give up their duties through incapacity or infirmity, they shall be entitled to the pension which the railway company gives. Also that no bye-laws or regulations shall be legal if it enacts anything unfavourable to military *employés;* and finally on getting one of these situations, an old non-commissioned officer can exchange his certificate for a 5th class pension according to the military rank he held on quitting the army, unless he is entitled to that pension, or to a higher one for other reasons. It is hoped by this means to get a sufficient number of berths for the requirements of the German Army. It is estimated that 127 non-commissioned officers per corps leave with a certificate every year; adding 60 for the Navy, and 418 for the police (they have certificates after nine years' service), and excluding Bavaria, this makes a total of 2,510, or 3,000 yearly at most, requiring situations. By the project of March, 1877, 77,000 posts are said to be thrown open to the Army, out of which—

1,884	yield a yearly	salary	of	1,500	marks	and upwards
2,473	„	„	„ from	1,200	to 1,500	marks
6,172	„	„	„ from	900	to 1,200	„
and 18,700	„	„	„ of	900	marks.	

Probably a large number are not very valuable, but all companies and societies are obliged to advertise in the *Militair-Wochenblatt* what vacancies they have, so as to allow non-commissioned officers with certificates to see what is in the market, and to apply for anything they consider suitable.

Notwithstanding all that has been done, there has been a great deficiency in old and really efficient non-commissioned officers, and some more legislation may be required. Will the Germans persist in taxing their industrial enterprise, and force a certain class of *employé* upon it, or will they raise a fund as fairly as they can from that portion of the Empire which contributes least to their military establishments, and give bounties to their old servants? Within the last few months,

however, an improvement has been observed, and non-commissioned officers do not appear to be so difficult to keep, as was the case formerly; this is due almost entirely to the depression in trade which at present exists in North Germany. This fact will doubtless enable the Government for the present to withhold any further rewards.

Quite recently a new military grade has been created, called *Feldwebel-Lieutenant*, holding a subordinate position among the Officers of the Landwehr, and ranking between a Cadet and a Lieutenant. These posts are to be filled by old non-commissioned officers, who are in good circumstances and otherwise fit for the position. They rank after Second Lieutenant, and can join their regiments without being balloted for; they are exempt from the courts of honour, and instead of a commission (*Patent*) they receive a warrant (*Bestallung*) according to the custom followed in the cases of the *Feldwebel* of the Guard. Their duties are those of Officers, but their pay is not stated in the Cabinet order by which they were created.

France.

France can hardly be said to have altogether recovered herself since the war of 1870–71, which upset all her military institutions; she is reconstructing herself gradually, and laws regulating the supply of non-commissioned officers are expected, but not yet passed. Moreover, she is a rich country with a flourishing trade, and improving manufactures, and her difficulties with regard to the question therefore are all the greater. The rules at present in force do not secure their object, for the inducements offered are not sufficient. Formerly, bounties were given to re-engaged men, and this answered tolerably well, but as they have been done away with, good non-commissioned officers are all the more difficult to be got. In 1873 there were in the French Army, exclusive of 82 depôts, 494 battalions; only 571 men, or little more than 1 per battalion re-engaged for 5 years. Such being the case, the French Government is obliged to promote soldiers before they have finished their first term of service, and thus the non-commissioned officers are too young and inexperienced. The law of 10th July, 1874, to take effect the 1st January following, endeavoured to rectify this state of things. It provided that the pay should be increased to the following:—A regimental sergeant-major, infantry, 2·33 francs; in the artillery, 3·25 francs per day; pay-sergeants, infantry, 1·40 francs; artillery, 2·60 francs; a sergeant, 1·10 francs, artillery, 1·35 francs. Re-engaged non-commissioned officers to receive an extra pay of 30 centimes daily, and after 10 years' service an extra 20 centimes. After 15 years' service, or 35 years of age, a pension is obtainable, reckoned according to a particular proportion, in such a manner, that for each year of service and each campaign $\frac{1}{25}$ of the full pension of 25 years' service is given; provided that the sum of the pension and the pay of a Government situation shall not exceed 1,200 francs. After 12 years' service, four of which must have been spent as a non-commissioned officer, they may receive appointments in the public service, post offices, telegraphs, railways, and public offices. This law

has not answered the expectations of the framers, and still men will not remain in the Army.

The education given to French non-commissoned officers is being improved, but it is not yet on an altogether satisfactory footing. These are trained merely in the regimental schools which exist in every regiment of infantry, cavalry, and artillery, but sufficient time is not given to learn much. These schools are divided into three, viz., those of the 1st, 2nd, and 3rd degree. The school of the 1st degree is quite elementary, it exists in every company, squadron, and battery under the captain; it confines itself to reading, writing, and arithmetic as far as the four rules; the teachers are unpaid, and the instruction is obligatory on all soldiers not acquainted with these subjects. It lasts an hour a day at least; in winter, two hours if possible. The schools of the 2nd degree embrace German, arithmetic, general ideas of geography and of minor operations of war; these are instituted for corporals for promotion, also for sergeants and one-year volunteers. The course lasts one year, but the instruction is only given twice a week, and for 1½ hours each time. Those of the 3rd degree teach French (composition and dictation), arithmetic, history, geography, elements of plane geometry, reading maps, field fortification. The attendance at the latter is voluntary, it is for non-commissioned officers and one year volunteers; no man can be recommended for the rank of Sub-Lieutenant from the ranks, unless he has passed the 3rd degree school, or proves that he knows as much as he could learn there. In 1875, moreover, an improvement took place, and a school—"*Ecole d'essai des enfants de "troupe*"—was established at Bambouillet, and an attempt made to found an institution for the purpose of training non-commissioned officers, in the manner done in Germany and Italy. Boys on the strength of a corps, and recommended by the General in command, to the number of 600, are admitted; 30 of these must pay, but the remainder are free. Great opposition has been made against opening it to any children except those of soldiers, and this is at present the rule. This experimental school has not proved a failure, and it is probable that not only will it be reckoned soon among the permanent institutions of the country, but that others will also be founded for the same purpose. The "*Ecole d'application de Cavalerie*," at Saumur, also trains some non-commissioned officers, and some of the men to become instructors in the cavalry, artillery, and train, the former as Officers, the latter as sergeants. The course of the first lasts a year, and on passing the final examination they are promoted to a commission at once, or on the first vacancies. The course of the second lasts 18 months, and comprises cavalry regulations, rough riding, veterinary science, military legislation, artillery, fortification, military art, topography, and German; at the end of 6 months, on passing an examination, the student is made a corporal, at the end of another 6 months, one-third on the top of the list are promoted sergeants, the remainder on leaving the school. The school at Saumur is also open to cavalry Officers who go through courses of instruction. Finally there are two schools through which sergeants can be promoted to commissions,

(1) that at Vincennes for the administrative branches of the Army, and (2) that at Bourges ("*Ecole de Sous-Officiers d'infanterie*"). All (with very few exceptions) who wish to rise from the ranks must go through this school; the course lasts one year; the number of students is generally 400, but it must not exceed 450. This school, which affects the commissioned ranks of the French Army rather than the others, is not yet considered by some to be on the best possible footing. There are too many students, and thus all do not get their promotion at once on leaving, but have to wait sometimes two or three years, even when high up on the list. The educational standard is not high enough, and men who have not sufficient general knowledge have been allowed to pass. Candidates with greater qualifications and fewer in number may, perhaps, for the future, be the only ones admitted.

General Rochebouët, for a short time War Minister, has lately (10th December last, to take effect 1st January, 1878) placed the military education of the French Army, comprising all relating to non-commissioned officers, &c., under a new *bureau*. The business of this office is now conducted by an infantry Officer, assisted by two or three Officers and clerks. Some new regulations for non-commissioned officers are expected; but the political events which took place in the country last year have required so much attention in another direction, that nothing has hitherto been done. It appears, however, that General Garnier, who now commands the 8th Army Corps, which a short time ago was under General Ducrot, has been employed by the Government to draw up a project to solve the non-commissioned officers' difficulty. A committee of twenty-two members of Deputies in the late French Chamber was formed to inquire into the subject, and a proposal was also made by a sub-committee and presented by General de Chanal. This latter includes the following points:—

(1.) Restrictions to the-one year volunteer system.

Public opinion in France has been very hostile to this method of easing a certain portion of the community of their military services. It is considered to be liable to abuse, and to be another form only of the old state of things, which caused so much harm to the country. Moreover the one-year volunteers form the very class from which the best non-commissioned officers should come, and thus it is the desire of General de Chanal to diminish their number. He would allow those with university degrees still to perform this short service, but those who get the advantage by an examination alone, should be less numerous, and reduced to 2 per cent. only of the previous year's contingent. Thus, instead of 9,500 one-year volunteers, he would allow but 3,000, or 2,500 with a university degree, and 500 admitted by examination.

(2.) Voluntary service might commence at 17 years of age, if the candidate were physically fit.

(3.) The formation of non-commissioned officers' schools in every regiment, or battalion separately administered.

This school should be organized as a company, but in case of mobilization it is to be done away with. Men likely to make good non-commissioned officers are taken, and their promotion depends upon

their aptitude and merit. Every year also the smartest who have attained the rank of sergeant-major may compete for admittance into the Military College to become Officers. This rule is explained by General de Chanal as being necessary, so that all the Officers of the Army shall be of *one* origin (that is from the ranks); but it has been pointed out that he really only insists on two-thirds of the number of the candidates coming from that source.

(4.) Civil posts.

The principle enunciated is that having served the obligatory term, nothing is to be expected from the State; but in order to gain the advantages of employment by the civil authority, certain extra service must be performed. Consequently the scheme enacts that all those who desire to get any place whatever paid by the State, must have served the country, by having been an Officer, or by having obtained a degree in the schools of medicine, agriculture, &c., or by having been a non-commissioned officer for four years, or by having been a corporal or soldier three years beyond the obligatory term. There are some exceptions to this rule, probably in favour of those who could not serve in the Army.

(5.) High pay and annuities.

Every non-commissioned officer and soldier can re-engage for 2 to 5 years beyond his obligatory term under the colours. He can do so when he has served one year, and thereby he receives an extra daily pay of 10 centimes if a private, and 15 centimes if above that rank. A second term of re-engagement is also allowed with the consent of the Commanding Officer, in which case the extra pay is doubled. Besides, men who are permitted to remain in the service five years after their compulsory term, receive an annuity of 15 fr. the first year, increasing 10fr. each year for the remaining four years of their re-engagement, if corporals and soldiers; and if above that rank 30 fr. first year, increasing 20 fr. These sums are procured from a capital which is granted by the State, but which is not payable to the man until he leaves the Army. A second re-engagement is allowed, and the same advantages as in the former are given. Those who sell their reversion of these sums or discount them, are broken, and thereby lose all right to them. A third re-engagement is also allowed on application to the Minister of War, but with no extra pay or annuity. At the end of 15 years' service according to this plan a man would be entitled to a sum of 2,200 fr. (£88), a non-commissioned officer to 4,400 fr. (£176).

(6.) Position of non-commissioned officers.

Facilities for marriage are given. Reduction to the ranks can only be effected by a Ministerial order, or by the General of Brigade in case of corporals.

M. Laisant, a Member of the Chamber of Deputies, also brought forward, in November, 1876, a scheme which was referred to the Committee already mentioned, but there has been no opportunity for discussing it as yet; and accordingly he has again presented it to the present Chamber. He aims at giving non-commissioned officers who have proved their worth, and have remained in the service six years,

a certain real status held by a certificate bestowing upon them a permanent grade—*il recevra une commission en vertu de laquelle il deviendra propriétaire du grade de Sous-Officier. Le grade conféré par le Président de la République constitue l'état de Sous-Officier commissioné*—and this position cannot be forfeited except on account of certain crimes. Next, another rank is created, "*premier sergent.*" Again, it is proposed that the pay should be the same in every branch of the Army, and should increase with the service of the soldier. This is rated as follows:—*Adjudants* (battalion sergeant-majors), up to 3 years' service, 2 fr. 30 c. per diem; after 3 years, 2 fr. 45 c.; after 6 years, 2 fr. 60 c.; after 9 years, 2 fr. 80 c.; after 12 years, 3 f.; after 15 years, 3 fr. 30 c.: after 20 years, 3 fr. 60 c. The other ranks in proportion, commencing from the following: (for men under 3 years' service) sergeant-major 1 fr. 40 c., *premier sergent* 1 fr. 15 c., sergeant 1 fr., and increasing nearly in the same manner as the pay of the *adjudant*. After 20 years a pension is obtainable, from 600 to 700 fr. yearly, according to the grade of the man; this pension is increased by 10 fr. for every year's service or campaign after the 20 years. All those who have a certificate of permanent grade (*Sous-Officier commissioné*) have a right to a pension, if they are invalided in the service of the country. After 9 years' service (4 a non-commissioned officer) a soldier can demand a situation in civil life; his application goes in, and he continues his duty until a vacancy occurs; he then tries the post for six months, being still kept on in the Army; should he be found fit for it, and if he consents to undertake it, he is struck off the list of the regiment; if not he returns to his duty. It is also contemplated by M. Laisant's scheme to extend the list of posts for which old soldiers are available, and this should embrace those on the lines of railway (belonging to private companies). Finally, there is a hope expressed that non-commissioned officers shall be made as comfortable as possible, more especially those who have their certificates of permanent grade; they should be able to marry, and a mess (*cercle*) should be established, besides libraries for their convenience and instruction. This project still contemplates promotion from the ranks; it confesses that the rank of Captain is the highest which, as a rule, a non-commissioned officer can attain to; it is proposed that its pay be increased, as it is not sufficiently high to make young men care for the position it offers.

General Berthaut, late Minister of War, also presented a scheme to the Chambers in 1877; and this is the one which the Committee adopted. In this project the legal status of the non-commissioned officer is objected to, because, first, it is a mere ideal advantage without a material equivalent; and because, secondly, it might make non-commissioned officers somewhat too independent of their chiefs. At the same time it is conceded that in the Army Regulations a definite grade of the sort may be granted, but that this should not be done by statute. Non-commissioned officers allowed to re-engage, have a sum paid to their credit, rated at 600 francs for each of the first four years in which they serve as re-engaged men. A sixth of that money, or less, may be paid to them as a bounty when it becomes due; the remainder (or the whole if the bounty is not claimed) is placed in the Funds, and yields its interest

to them. The right to sell out is only given when they quit the service. In case of death with the regiment, the widow or next heir receives the full sum of money which should be in the Funds (viz., 2,400 fr.) For wounds or disease contracted in the public service, the man receives the same amount, and in case of promotion to a commission, or an appointment out of the Army, a proportional part is allowed. A proportional part only is also given to those who have been injured otherwise than is mentioned above; those who are reduced to the ranks have a right only to the money earned at the time they committed the fault, the permission however to sell out of the Funds being only granted on the completion of their four years' re-engagement.

Instead of the provisions as to extra pay and pensions, already quoted from the law of the 10th July, 1874, non-commissioned officers, according to General Berthaut's scheme, are to get an increase of 50 centimes per diem after 9 years' service, and a pension after 12 years' service, whose rate is reckoned for each year and for each campaign, at $\frac{1}{25}$th of the full pension due after 25 years in the Army. Civil employments are also to be open to non-commissioned officers; and it is reckoned by General Berthaut that his project will give about 2,000 re-engaged soldiers per year. The Minister would, of course, have the right to reduce this number according to the requirements of the country.

The French military world is naturally devoting much attention to this question (as well as to those plans for the reduction of the compulsory term of service from five to three years, and for the suppression of the one-year volunteers), and many are the opinions put forward. Space would not, however, permit us to repeat these various projects. Suffice it to say, that most tend to the plan of giving a bounty after a certain number of years' service, as the best means of inducing men to re-engage, as giving them the greatest possible facilities for getting work when they leave the Army, and as not interfering with the industry of the land. Few proposals, however, have been put forward as to a special fund for the payment of these bounties, and in this respect the tendency in France is not the same (as will be seen) as in Italy. According to the schemes already mentioned, nothing has been said about this; the money required, being raised in the war budget. One scheme by a general Officer, advocating a special fund, may be perhaps touched upon in conclusion. He considers that during the first term of service, non-commissioned officers should belong to the 2nd class; afterwards (re-engagement for 7 years) to the 1st class; during this latter period they receive extra pay, distinctions in their uniform, and better barrack accommodation. At the end of this re-engagement (12 years' service) they should get an annuity for life of 300 francs. Should they desire to re-engage again, they may do so for another 5 years, and at the end of 17 years' service, receive an annuity of 500 francs for life. If they are promoted to Sub-Lieutenant during the second term of re-engaged service, they still retain the 300 francs pension. This money is to be derived from the fines payable by one-year volunteers.

Austria.

In the Austrian Army non-commissioned officers are obtained:—

(1.) By promotion from the rank and file. Intelligent and well-conducted men, those who are likely to be of use, are promoted when vacancies occur, provided they have served the minimum term laid down by regulation. No man may be a corporal until he has been in the ranks six months as private, nor a sergeant (or sergeant-major) until he has served one year. For the training of privates, and for the future instruction of those already promoted, regimental schools have been established, and to these further reference will be made.

(2.) By direct appointment, on passing certain qualifying examinations, after having been a student at one of the military academies of the Empire. These institutions are mainly intended to educate the sons of deserving but poor Officers, and in many cases the pupils are maintained free (or nearly free) of all expense to the parents. Most of those whose military education is paid, must sign an obligation (to be ratified by the parents or guardians), by which they agree to serve a year above the legal term, for each year or part of a year spent at school. Those who are semi-dependent on Government aid, must remain in the ranks half that extra time. Those that pay for their education have also to consent to one year's extra service, if they have been four years or more at the school. The whole period under the colours is, however, in no case to exceed 10 years.

There are three of these schools, viz.:—(1.) The Military Technical School (*Militär Ober-Realschule*), a preparation to the Military Technical Academy, of which more will be said further on. Students have to remain at this *Ober-Realschule* for three years, and in finishing their course they receive a certificate marked "excellent," "good," or "satisfactory." Those in the highest class are sent to the Military Technical Academy as vacancies occur; those in the next category become non-commissioned officers in the artillery; and those in the lowest are made 1st class gunners. There are 450 pupils; and the course includes German, French, Bohemian or Hungarian, surveying, physical sciences, geography, history, artillery, geometry, and drill. (2.) The Military Academy (*Militär Academie für Neustadt*), with its preparatory school—the Military College. The object here is to furnish a certain number of Officers to the infantry, rifles, and cavalry; there are 380 students; the course lasts four years, and the standard of education is much higher than that already given. Those that pass are appointed Lieutenants, but those who fail enter the Army as non-commissioned officers. (3.) The Military Technical Academy (*Militär Technische Academie*) to which the best pupils of the *Ober-Realschule* are sent. The instruction given is about the same as that in the Military Academy; there are 270 pupils, and the course lasts four years. Those that pass become Lieutenants, those that fail are appointed non-commissioned officers.

The term General is applied to that portion of the regimental schools which are destined to educate non-commissioned officers and men. There are four classes; the 1st class is divided into two

to them. The right to sell out is only given when they quit the service. In case of death with the regiment, the widow or next heir receives the full sum of money which should be in the Funds (viz., 2,400 fr.) For wounds or disease contracted in the public service, the man receives the same amount, and in case of promotion to a commission, or an appointment out of the Army, a proportional part is allowed. A proportional part only is also given to those who have been injured otherwise than is mentioned above; those who are reduced to the ranks have a right only to the money earned at the time they committed the fault, the permission however to sell out of the Funds being only granted on the completion of their four years' re-engagement.

Instead of the provisions as to extra pay and pensions, already quoted from the law of the 10th July, 1874, non-commissioned officers, according to General Berthaut's scheme, are to get an increase of 50 centimes per diem after 9 years' service, and a pension after 12 years' service, whose rate is reckoned for each year and for each campaign, at $\frac{1}{25}$th of the full pension due after 25 years in the Army. Civil employments are also to be open to non-commissioned officers; and it is reckoned by General Berthaut that his project will give about 2,000 re-engaged soldiers per year. The Minister would, of course, have the right to reduce this number according to the requirements of the country.

The French military world is naturally devoting much attention to this question (as well as to those plans for the reduction of the compulsory term of service from five to three years, and for the suppression of the one-year volunteers), and many are the opinions put forward. Space would not, however, permit us to repeat these various projects. Suffice it to say, that most tend to the plan of giving a bounty after a certain number of years' service, as the best means of inducing men to re-engage, as giving them the greatest possible facilities for getting work when they leave the Army, and as not interfering with the industry of the land. Few proposals, however, have been put forward as to a special fund for the payment of these bounties, and in this respect the tendency in France is not the same (as will be seen) as in Italy. According to the schemes already mentioned, nothing has been said about this; the money required, being raised in the war budget. One scheme by a general Officer, advocating a special fund, may be perhaps touched upon in conclusion. He considers that during the first term of service, non-commissioned officers should belong to the 2nd class; afterwards (re-engagement for 7 years) to the 1st class; during this latter period they receive extra pay, distinctions in their uniform, and better barrack accommodation. At the end of this re-engagement (12 years' service) they should get an annuity for life of 300 francs. Should they desire to re-engage again, they may do so for another 5 years, and at the end of 17 years' service, receive an annuity of 500 francs for life. If they are promoted to Sub-Lieutenant during the second term of re-engaged service, they still retain the 300 francs pension. This money is to be derived from the fines payable by one-year volunteers.

Austria.

In the Austrian Army non-commissioned officers are obtained:—

(1.) By promotion from the rank and file. Intelligent and well-conducted men, those who are likely to be of use, are promoted when vacancies occur, provided they have served the minimum term laid down by regulation. No man may be a corporal until he has been in the ranks six months as private, nor a sergeant (or sergeant-major) until he has served one year. For the training of privates, and for the future instruction of those already promoted, regimental schools have been established, and to these further reference will be made.

(2.) By direct appointment, on passing certain qualifying examinations, after having been a student at one of the military academies of the Empire. These institutions are mainly intended to educate the sons of deserving but poor Officers, and in many cases the pupils are maintained free (or nearly free) of all expense to the parents. Most of those whose military education is paid, must sign an obligation (to be ratified by the parents or guardians), by which they agree to serve a year above the legal term, for each year or part of a year spent at school. Those who are semi-dependent on Government aid, must remain in the ranks half that extra time. Those that pay for their education have also to consent to one year's extra service, if they have been four years or more at the school. The whole period under the colours is, however, in no case to exceed 10 years.

There are three of these schools, viz.:—(1.) The Military Technical School (*Militär Ober-Realschule*), a preparation to the Military Technical Academy, of which more will be said further on. Students have to remain at this *Ober-Realschule* for three years, and in finishing their course they receive a certificate marked "excellent," "good," or "satisfactory." Those in the highest class are sent to the Military Technical Academy as vacancies occur; those in the next category become non-commissioned officers in the artillery; and those in the lowest are made 1st class gunners. There are 450 pupils; and the course includes German, French, Bohemian or Hungarian, surveying, physical sciences, geography, history, artillery, geometry, and drill. (2.) The Military Academy (*Militär Academie für Neustadt*), with its preparatory school—the Military College. The object here is to furnish a certain number of Officers to the infantry, rifles, and cavalry; there are 380 students; the course lasts four years, and the standard of education is much higher than that already given. Those that pass are appointed Lieutenants, but those who fail enter the Army as non-commissioned officers. (3.) The Military Technical Academy (*Militär Technische Academie*) to which the best pupils of the *Ober-Realschule* are sent. The instruction given is about the same as that in the Military Academy; there are 270 pupils, and the course lasts four years. Those that pass become Lieutenants, those that fail are appointed non-commissioned officers.

The term General is applied to that portion of the regimental schools which are destined to educate non-commissioned officers and men. There are four classes; the 1st class is divided into two

sections, viz.:—(*a*,) instruction for the ordinary rank and file; (*b*,) for non-commissioned officers and those of the privates likely to get promotion. The 2nd and 3rd classes include those that are trained for special duties, as pioneers, drivers, hospital orderlies, police, pay-sergeants. The 4th class is for one-year volunteers; this too is divided into two sections, viz.:—(*a*,) for those who qualify for non-commissioned officers; (*b*,) for those who wish to become officers of Reserve.

The highest non-commissioned grade is Cadet, which is really an aspirant to the rank of Officer. Men are appointed to this position by the War Minister (all other non-commissioned officers are made by the Commanding Officer), but they must either go through the Cadet schools, or else present themselves at the final examination. The rules and the standard of education in these schools are made more with a view to instruct an Officer than a non-commissioned officer. They bear great resemblance to the Younker schools in Russia.

The period of service in Austria is three years. Re-engagements are made after that term for one year at a time, and these can be renewed with the consent of the Commanding Officer eighteen times, until the man has 21 years' service. Re-engaged men receive extra pay, which, however, does not increase with increase of service; it is paid fortnightly, and amounts to 17 florins[1] for a sergeant-major, 14 florins for a sergeant, and 9 florins 40 kreutzers for a corporal per month. Service with the colours, after the legal term has passed, counts towards that in the Reserve, and afterwards in the Landwehr. Bounties are also paid, and these amount to £6 after the first year, to £12 after two years, to £19 after three years, to £26 after four years, and to £126 after twelve years of re-engaged service. Distinctive badges are, moreover, worn on the arm denoting good service.

The money required to furnish this re-engaged pay was first raised in 1849 by fines payable by volunteers. At that time a very trifling additional sum was given to the men who remained on in the service, but the amount was secured to them for life, and in case of death it was convertible into 30 florins. A little later the *remplaçant* system was introduced, and re-engaged men were paid higher out of the capital thus raised. At the end of their service they received a bounty which varied between 1,000 and 1,500 florins. By skilful management a fund was created, which now forms the principal source whence the extra rewards are given to non-commissioned officers. Towards the end of the year 1857, however, the money so accumulated was used for other purposes, and did not benefit, as was intended, the subordinate portion of the commanding *personnel* of the Austrian Army; in that year 23,000,000 florins were diverted to other State expenses, principally for the manufacture of war material. But in 1860 the first step was taken to settle the income derived into a *permanent* fund; and by this means the money in hand has steadily increased, until the introduction of universal service without exemption prevented it from receiving any more fines. The same military regulation obliged the Government also to reduce their re-engaged pay to

[1] A florin is equal to 60 kreutzers, or to 1*s*. 8*d*. in English money.

the amounts stated above. The fund created by the *remplaçant* system of the past, bears a yearly interest now of 1,279,926 florins. In 1877, 6,573 sergeant-majors, 11,361 sergeants, and 17,714 corporals were re-engaged men, and received the extra pay which was attached to that position; in round numbers, the amount of money required to defray this was 1,900,000 florins, leaving a surplus of 620,000 florins, to be obtained elsewhere from the State. It is by no means certain that the fund will remain untouched and available for its original purpose; it has once before been appropriated, and a want in the Treasury (which is now said to be felt) might be conveniently satisfied by it. On the other hand, all military opinion is convinced of the necessity of giving an allowance to re-engaged non-commissioned officers, since Austria has always adopted that system; if, therefore, this special fund is done away with, something else will, in all probability, be established.

Pay in Austria is two-fold: *Löhnung* or actual wages, and *Menage-geld* or that in lieu of rations, and payable every five days in advance. This latter varies according to the market prices of provisions, and it is optional whether the men take the allowance in money or the rations in kind. The *Löhnung* amounts to 15 kreutzers per day for a corporal, 20 kreutzers for a sergeant, and 35 kreutzers for a sergeant-major or a cadet; these latter have an allowance, called *Diensteszulage*, of 8 florins per month, and this is payable whether they re-engage or not. The *Menage-geld* is not intended to cover bread, firing, and lights and tobacco, which are provided otherwise.

In barracks corporals and sergeants live with the men, but sergeant-majors, cadets, and one-year volunteers, have generally separate rooms. Non-commissioned officers are free to take their meals where they like. As to marriage, 4 per cent. of the effective are on the strength of the regiment, and their families amenable to martial law; these have quarters or an allowance; also when sick in hospital, or away on duty in peace, or when away in the field, the family gets the following advantages:—(1) One ration of bread for the wife, and half for each child, per day; (2) The menage-geld which the husband was entitled to; and (3) lodgings free. The remainder may get leave from the Commanding Officer to marry, but they have no privileges. Non-commissioned officers used to be allowed to remain out of barracks as long as they liked, without leave, after tattoo; but this permission has been cancelled, because the men were not looked after, and the indulgence was found to be unduly great, giving occasion to irregularities.

Punishments in the Austrian Army are as follows:—Sergeant-majors and Cadets may be (1) reprimanded, by word of mouth, in writing, or in presence of all those of equal rank and those above them; (2) leave may be stopped, or even the offender may be ordered to return to barracks at a specified hour before tattoo, for 30 days; (3) room arrest, or open arrest for 30 days; (4) reduction to the ranks, after having been formally warned (this punishment does not apply to a Cadet). Sergeants and corporals are subject to the same punishments as the men, with the exception that they cannot be awarded black-hole, nor can they be "tied up" for 2 hours; they may, however, be

reduced after formal warning. Strict arrest, to which they are liable, means imprisonment for 30 days, without hard labour; solitary confinement can be extended to 21 days. All these punishments are given without trial, but the most severe of them, *e.g.*, reduction, and the full term of imprisonment, can only be inflicted by the Officer commanding the regiment.

Two corps of the Imperial Royal Guard are recruited from the smartest and best conducted non-commissioned officers of the Army. The Trabanten Body Guard, who reckon 48 soldiers (excluding officers, &c.), and the squadron of Life Guards, 60 in number, get their men from this source. The engagement for these corps are respectively three and four years; afterwards re-engagements from year to year. Candidates must be under 35 years old to enter; but there is no limit to age when they must leave.

Promotion from the ranks, properly so called, can hardly be said to exist in Austria. Many candidates for commissions have to go through the different ranks of the Army, but that is with a view to training the Officer himself, not to reward the non-commissioned officer who has proved himself smart and useful in his subordinate sphere. A non-commissioned officer must be first appointed a Cadet, and go through the necessary examinations; he can then only be promoted, after all the Officers of his future regiment have given their consent to allow him to be admitted among them, as being in every way fitted for his new position. In war time non-commissioned officers, who have distinguished themselves before the enemy, and who have received the consent of the Officers of the regiment, are eligible for promotion to a commission.

In Austria there are no pensions for long service, but old soldiers are enabled to receive civil appointments instead. In 1872 and 1873 laws were passed in Austria and in Hungary on this subject. By these, men who have been on the active list for twelve years, eight of which must be spent as a non-commissioned officer, and who are well conducted, acquire a claim to be granted situations in the public service, railways, steam navigations, or other undertakings, which are guaranteed or licensed by the State. Also, those have the same privileges who have been injured in war time, or in the execution of police duties, and who are therefore unfit for military service, but still qualified to undertake civil employment. Civilian candidates are not allowed to compete, if there is a military applicant requiring the post, who is not manifestly unfit for it. From time to time lists are published, stating the vacancies which occur in the civil administration of the country, also the time within which the application must be made for them. If one of these situations is given away illegally—that is to a man having no military claim, when an army candidate was at hand—the appointment is declared null, and has to be given up, except when it has been held for one year; in which case 100 to 500 florins is paid as a fine to the poor-box of the parish. When a licence is given to any railway or steam boat company for the public traffic, the company, even when not guaranteed by the State, is bound by the above laws. Another appointment, open to old non-commissioned officers, who

have qualified themselves for civilian employment, is that of sergeant-major of Landwehr district. The country is divided into Landwehr company districts, and each has a sergeant-major or *Bezirks Feldwebel*. Failing men of twelve years' service, those of ten years—or belonging to the class which is just entering the Landwehr—may be selected. This appointment is worth 600 florins per annum, and increases by 100 florins at the end of five years' service in the post; by 200 florins at the end of 10 years; and 300 florins after 15 years. Besides this pay, the *Bezirks Feldwebel* receives lodging allowance, only a little inferior to that to which a Sub-Lieutenant is entitled.

The system above described does not seem to answer, and the military authorities in the Empire are by no means exempt from trouble in the matter. Quoting from the *Vedette*, an Austrian newspaper, the *Bulletin de la Réunion des Officiers*, of last November, says, that the dearth in non-commissioned officers has never been greater than in 1877; and that even re-engaged men leave the Army as soon as they can. This difficulty, it should be remembered also, is felt far more in Austria Proper, and in the richer provinces, than in Hungary, Dalmatia, Croatia, Gallicia, &c., where trade and manufactures are not so flourishing. We have not, however, seen any proposals yet for remedying this state of things, and consequently it is impossible to conjecture what will be done, if the regulations now in force fail to attract men, to serve the State in the subordinate portion of the commanding *personnel* of the Army.

Russia.

Only a short time ago a sufficient number of old soldiers were always to be found in Russia, from which to draw material for non-commissioned officers. Those that served in the Army were cut off, as it were, from their original homes; they lost their communal rights, and were often obliged to remain with the colours out of sheer necessity. Provision seems to have been made for them; they were not sent away, and hence there was always an abundance of men for promotion, men who looked to the Army alone as their home, and as the scene of their life's career. Thus the very elements necessary for good non-commissioned officers according to the old type, were at hand. In 1867, however, soldiers were permitted to retain their communal rights, and during the last fifteen years Russian industries have greatly increased, so that a peasant can now find work where it was formerly impossible; thus it is that men having completed their term of service, leave the ranks, to enter upon other walks in life. Considering that the term of service was long—15 years—this might not have affected very seriously the *cadre* of non-commissioned officers, had it not been that this also was reduced to five years in the ranks. On account of this change, Russia has also been obliged to regulate the recruitment and the reward of her non-commissioned officers.

There are two classes of non-commissioned officers.

(1.) Those who are illiterate, or nearly illiterate, from the lowest classes of society; and

(2.) Those that can pass a certain qualifying examination, and who

are either one-year volunteers or have been drawn into the ranks by lot. (In Russia it should be remembered there is universal conscription without exemption; the War Minister, however, determines the requirements of the yearly contingent, and this is taken by lots, the remainder being drafted into the militia.)

The latter appear to be rather Cadets than non-commissioned officers; they are promoted without vacancies, they have certain privileges, are better kept, and, as a rule, get promoted to commissions. From the former class, non-commissioned officers, properly so called, are taken; as a rule only 8 to 10 per cent. of the recruits are able to read, and thus it is necessary to send all those who are likely to be of use to a military school, and after two years' instruction, on vacancies occurring, they are promoted to the rank of corporal (*Mladshji Unter-Offizier*). Non-commissioned officers in Russia receive their rations, clothing, billets, and barracks accommodation (this latter is not sufficient for the whole Army), but their pay is rather pocket-money than anything else. It is payable three times a year, and amounts to—

	Inf.	Cav.	Art.
For a Sergeant-Major (*Feldwebel*)	24 roubles,	24 r.,	36 r., yearly.
Sergeant (*Starshji Unter-Offizier*).	18 „	18 „	24 „ „
Corporal (*Mladshji Unter-Offizier*)	4 r. 5 c.,	4 r. 5 c.,	9 „ „

In 1871 certain regulations were made by which non-commissioned officers alone were permitted to re-engage after their obligatory service (five years), and if they did so it was at least to be for one year. Extra pay for a *feldwebel* 42 roubles,[1] sergeant 30 r., and corporal 21 r. per year was given to re-engaged men. In 1874 this extra pay was increased to 84 roubles for a *feldwebel*, and 60 r. for a sergeant per year, the corporal receiving nothing; and other rules were published by which useful soldiers (musicians, clerks, &c.), as well as non-commissioned officers, can be re-engaged at least for one year. They can even return to the ranks from the Reserve, if they have not been more than three years (one year for soldiers) away. Non-commissioned officers during their first five years of re-engagement are entitled to a silver chevron on their left arm, after the completion of this term they can remain on wearing a gold chevron, after ten years they receive a silver medal, on which is inscribed "for zeal," to be worn on the breast, and after fifteen years a gold and silver medal, likewise having the words "for "zeal," to be hung round the neck. Again, after the first five years of re-engaged service, a man is entitled to a certificate recommending him to a civil employment.

In March, 1877, the last regulations were issued, and by these—

(1.) Men who have completed their first five years of re-engaged service, and having received certificates of recommendation, are to be preferred to all others as candidates for employment in the civil and even military administration of the Empire.

(2.) Non-commissioned officers in the receipt of extra pay can, if they wish to leave, receive a bounty of 250 roubles after ten years'

[1] The silver rouble is worth 3*s.* 2*d.* The present rouble is paper, and has diminished very greatly in value; a rouble is equal to 100 copecks.

re-engaged service, and after twenty years a pension of 96 roubles the year, or a bounty of 1,000 roubles paid down. If wounded or mutilated in war or in the service of the country, the lesser bounty is paid after seven years, and the greater (or pension) after fifteen years; these are independent of any annuity which the committee who decides on the claims of the wounded may bestow. In case of death, the widows of the above-mentioned men receive 36 roubles the year.

(3.) Corporals who get no extra pay are entitled to it when promoted, not only from that date, but for all their previous re-engaged service. They also receive the bounties (or pension) as above, provided they have been a year in the rank entitled to extra pay.

(4.) Non-commissioned officers, if they return to the colours from the Reserve, are permitted to count their former re-engaged service; but those who leave after their tenth year and take the bounty (250 roubles) lose all right to the higher reward if they again enter the Army.

By these arrangements a man at about 35 is entitled to a sum of 250 roubles and a chance of an employment in civil life, while if he remains another ten years in the Army he is given a capital of 1,000 roubles, or a small pension of 98 roubles for life, when he is about 45 years old. After five years as non-commissioned officer a man may get leave to marry, in which case quarters are usually given to him, and a small allowance for his children, up to 14 years old for boys and 10 for girls.

Above the sergeant-major (*feldwebel*) there is another rank in the Russian Army which is not commissioned, called *Porte Epeé Younker*. Promotion to this grade can only be obtained by passing through a special school. The pay attached to it is 100 roubles a year, and it appears to have certain privileges.

Younkers, or those passing the necessary examinations, are eligible to rise from the ranks (we are dealing with the 1st class of non-commissioned officers, viz., those that were enrolled as illiterates) after having completed their period of active service, of which one year must be passed as a non-commissioned officer. These Officers are usually posted to garrison troops, and their new position seems to be far from a happy one as they often give up their commissions, in which case they have a special pay and wear the *Younker* badge in silver. About two per cent. of the Russian Officers come from this source.

The regulations concerning civil posts are not yet fixed, for at the end of those issued in March, 1877, the intention of forming a special commission on the subject was announced. The war in Turkey has, of course, put an end to any such thing being carried out; indeed, it is almost impossible to say what will be the effect of these troubles on the question under consideration. We are informed, however, that in Russia there are about 80,000 posts in the civil administration of the Empire in the gift of the Government, with salaries varying from 85 roubles to 700 roubles per year. No qualification is required (except an elementary education, and a good character for zeal) for those worth 240 roubles. In order to obtain the others with a higher

pay, a good hand, technical knowledge, and quickness in accounts are necessary.

If the war does not shake the stability of the Russian military organization, it remains to be seen how these new rules will answer. Hitherto, re-engagements have been insufficient—only one-half the sergeant-majors, and fourteen per cent. of the sergeants being re-engaged men;—this may be due to the quiet and unaspiring tastes of the Muscovite peasant, who is no longer cut off from his home rights by serving the Czar, and who prefers his unobtrusive poverty to military service. On the other hand, these are the first attempts at securing the future comfort of old soldiers, and as soon as the regulations have had time to work, and time to bestow certain bounties, as well as good salaries upon those who shall become entitled to them, the Russian Army may be supplied with as good material for non-commissioned officers as the country affords.

Denmark.

Denmark, as a military nation, is insignificant when compared with the larger Powers of Europe; her position is, however, of great importance; and, surrounded as she is by far more powerful States, her military system has been organized more with a view to defence than to offence. Out of a population of something under 2,000,000 souls, Denmark's forces on a war footing may be considered at about 45,000 men, of whom 25,000 belong to the line, 10,000 to the reserve, and 10,000 to the augmentation. During peace time, only 9,000 men are retained for military instruction; and, during the winter months, 6,000 of these—chosen by lot among those who have passed through their drills satisfactorily—are sent to their homes, leaving but 3,000 men for garrisons, &c.

The Danish Army is divided into brigades, each composed of two demi-brigades (two battalions). The yearly contingent of recruits is sent alternately to the two battalions forming the demi-brigade, and thus each of the former receives its recruits only every two years. The men join in April for six months, and out of their number, 24 men per battalion are chosen for the corporals' schools, and one-tenth of the remainder for the lance-corporals' schools. For admission into the former, an elementary examination is required in subjects which are taught in the first class national schools. These men are all promoted lance-corporals, and remain at school during the winter until the following April; they are then transferred to the other battalion of the demi-brigades, and instruct the fresh batch of recruits in their preliminary work. Afterwards they return to their old battalion for the period of training under canvas, and then, if considered fit, they are promoted to the rank of corporal by the battalion commander; they may be then sent home on furlough, or kept on duty, according to the requirements of the Service. In each cavalry regiment 6 young men are selected for the corporals' school, 8 for the lance-corporals' school. In the Artillery, 87 gunners and 18 drivers for the former, 44 gunners and 20 drivers for the latter.

There are three divisions in the commanding *personnel* (viz., Officers and non-commissioned officers) of the Danish Army:—

1st. Those in temporary employment, viz., Second Lieutenants, and corporals and lance-corporals.

2nd. Those on permanent duty, viz., Generals, Colonels, Captains, and First Lieutenants, and staff sergeants, sergeant-majors, and sergeants.

3rd. Those on the augmentation, viz., same as in the 2nd division.

On a war footing a battalion must have 36 corporals, but on a peace footing 18 are considered sufficient. Men on promotion to corporals, if kept at duty, are retained for periods of service extending to one year (or sometimes two years, if the first period). Sergeants are appointed by the battalion commander from the grade of corporal, but they must not be over 32 years old; on this promotion, they pass from *temporary employment* to *permanent duty*. Two years as sergeant, at least, is necessary to qualify to become sergeant-major, and another two years to become staff sergeant; the latter of these appointments is made by the Brigadier. Non-commissioned officers are placed into the Augmentation on completion of their line service. Corporals may also sometimes be promoted from their regiments to sergeants on the Staff.

There are several schools established with a view to training non-commissioned officers. The first of these is the Elementary School, in which boys between 14 and 16, who are physically fit, are admitted by examination on the subjects taught in the lower national schools. It contains 120 pupils, divided into three classes, and the students are kept a year in each of these. The school bears some resemblance to the earlier forms of the German non-commissioned officers' school; it is organized into an infantry company, having a Captain as commandant and two Lieutenants, together with six staff and other sergeants (of the three arms of the Service) as instructors; there is also a civilian head master and two civilian assistants. The pupils are lodged, fed, clothed, and educated free; and their instruction comprises elementary knowledge, both technical and general, as well as practical work. On leaving, they enter the Army as privates; and, although designed for non-commissioned officers, they have no title to that rank, unless they are quite qualified for it; they have to go through the same course as the other men, and if they fail to pass the entrance examination for the corporals' school, they have to do duty as common soldiers. Those that pass are, however, held to remain under the colours as non-commissioned officers for two years.

The next educational institution includes the corporals' and lance-corporals' schools; in the infantry they are established in each demi-brigade under a Captain, three Lieutenants of at least two years' service, one staff sergeant, and eight sergeants of the battalion, whose turn it is to form the school that year; all the Second Lieutenants of the other battalion act as instructors. In the cavalry, artillery, and engineers, there is only one school for each. Those who are not sufficiently qualified for the corporals' school become candidates for the lance-corporals' school, but both are combined into one establishment, except in the cavalry, where each regiment has one of the latter. The course of instruction in the infantry lasts $5\frac{1}{2}$ months, in the cavalry

7½ months, in the artillery 8 months, and in the engineers 7 months; it comprises drill, and all that which is necessary for the proper discharge of a non-commissioned officer's duties. It ends with a final examination, and entitles a pupil to be promoted—if he possesses a satisfactory certificate from his Commanding Officer as to his fitness for duty—when he has completed his service as lance-corporal. Seniority is determined by the result of the final examination. Those that fail are sent home in their lance rank.

There are also sergeants' schools, for the purpose of instructing those who are retained for "permanent duty." These establishments are similar to those just described, and in the cavalry and artillery they are combined with them; the course also lasts about the same time, and the instruction is both practical and theoretical. It does not appear that it is necessary to go through this school in order to qualify for a sergeant's stripes, but preference seems to be given to those who have passed the final examination.

Non-commissioned officers have facilities for being promoted to Commissions. After passing the corporals' school, application is made to the War Minister to go through the lower class of the Officers' school; having passed this course successfully (it lasts thirty weeks), candidates then return to their battalions to undergo a practical test; if found to be satisfactory, they are promoted by the War Minister to the rank of Second Lieutenant, on "temporary employment." They are then either sent on furlough, or retained for a minimum period of one year at a time on duty, in the same way as corporals. For promotion to a commission on "permanent duty," Second Lieutenants must pass the second and third classes of the Officers' school, and obtain from their Commanding Officers a certificate of being qualified for the rank. This is the first step in the real commissioned ranks of the active army; and if a volunteer commences his career at the earliest possible age, viz., 18 years old—the compulsory age being 22—and gets on as rapidly as possible through the different schools of military instruction, he will be a First Lieutenant at 23 years of age. The appointment of Officers on "permanent duty" is made by the King; the candidate must be under 32 years old; promotion takes place afterwards by a mixture of selection and seniority, and Officers must have been at least a stated time in each grade before they get their next step. After certain ages they are disqualified for advancement. Non-commissioned officers also are given commissions in the Augmentation, and promotion goes from sergeant to Lieutenant, and so on. If a man finishes his service in the Augmentation, he may be re-appointed to it with a step in rank. Appointments, &c., in this portion of the Danish Army are proposed by the Brigadier, but made by the King in the case of Colonels and Captains; by the War Minister in the case of Lieutenants, and by the Brigadier for non-commissioned officers.

The Officers' school, through which it is necessary for a man to go in order to be promoted, is divided into four classes. The object of the lowest is to train non-commissioned officers to become Second Lieutenants. It contains 63 pupils for the infantry, 19 for the cavalry, 12 for the artillery, and 3 for the engineers. The course lasts from 30th

September till the following 25th April, and includes Danish language, mathematics, strategy and tactics, drawing, artillery, fortification, reconnaissance, and drill. The 2nd class is a preparation for the 3rd, the final examination of the former being the entrance to the latter. The instruction in the 2nd class is purely theoretical, and it is possible for candidates to miss it, by passing direct into the next class. It appears, therefore, that it is established merely as a means of facilitating uneducated men to qualify themselves in the higher knowledge required for the rank of an Officer on "permanent duty." The instruction in the 3rd class embraces military subjects, and the course lasts one year in the 2nd class, two years in the 3rd class. The 4th or senior class of the Officers' school is for the Staff.

Non-commissioned officers are entitled to pensions after having completed an active service of 20 years; this pension increases with the man's service until he has been with the colours 40 years. It also varies with the rank of the individual, who, to get the allowance of his grade, must have served three years in it. The pension of the senior non-commissioned officer (staff-sergeant) after 20 years is £15 11*s.* 3*d.* per annum; after 40 years it is £33 7*s.* 9*d.* That of a sergeant-major is £11 for the shorter term, and rises to £25 11*s.* 3*d.* for the longer; sergeant, £8 18*s.* 4*d.* and £20 3*s.*; corporal, £7 15*s.* 6*d.* and £16 13*s.* 10*d.*; lance-corporal, £6 14*s.* and £13 6*s.* 4½*d.*; and for a private, £5 11*s.* 3*d.* and £11 4*s.* 3*d.* Officers also receive pensions calculated according to their service; these amount to one-tenth of their pay if under two years' service, but increase gradually to two-thirds of the average rate of their pay (during the five years preceding discharge) if they have 29 years' service and over. In every case a campaign reckons as two years' service.

Invalid pensions are also accorded to the whole Danish Army when the injury has arisen by the performance of military duty; and these allowances may be made permanent or only for a year at a time. In certain cases the invalid, if an Officer, retires on full pay; non-commissioned officers and men receive a sum varying up to £22, according to rank, and according to the nature of the injury, in addition to the ordinary pension if over 20 years' service, or to a smaller allowance if under that period. When illness not due to the Service invalids a man, these sums are diminished; but in special cases they are increased. Widows of Officers and their children, up to 18 years old, are also allowed small pensions when the husband was himself in receipt of, or eligible for, a pension; in the case of non-commissioned officers and men, the widows and children, up to 15 years old, are in all cases allowed a small annual sum.

Non-commissioned officers are enabled to marry, with leave from their Commanding Officers; but they must be 25 years old, be of good conduct, and have sufficient means to support a family. Should a corporal marry on these terms, he is not permitted to rise in his profession, but is compulsorily sent home at the conclusion of his term on duty. In fact, no man on *temporary employment* who marries, is permitted to go upon *permanent duty*.

Second Lieutenants after one year's service as such, are entitled to

posts in the customs, telegraph and post offices, or to be employed as superintendents, &c., in the Royal palaces, &c. Corporals having served two years after passing the corporals' school have the same claim. Permanently posted non-commissioned officers, after 12 years' service, may be employed under town councils as warders, or in the police, &c.

Sweden.

In Sweden there are upper and lower schools for the education of non-commissioned officers of the infantry and cavalry. The latter, or preparatory schools, are established regimentally, every battalion sending 10 men for instruction. The course lasts 42 days, and includes reading, writing, arithmetic (including fractions), and drill. The former, or non-commissioned officers' schools, are two in number, viz., one at Fort Karlsborg for infantry, and the other at Stockholm for cavalry. They are divided into three classes; 1st class is to qualify men for the rank of corporal, 2nd class above that rank, and 3rd class (the senior) is to teach those men of any rank who are sufficiently advanced to profit by its instruction. The course lasts 120 days, and includes reading, writing, arithmetic, geometry, art of war, tactics, field fortification, surveying, instruction in elements of military surgery, and drill. Promotion takes place as vacancies occur, after the candidate has received a certificate as having passed successfully the examination of his class, and after his ability has been tested practically at the regimental head-quarters.

Education for the artillery is in the hands of the instructional department of each regiment, and is under the superintendence of a Captain and a Lieutenant. There are two sections; the junior for corporals and non-commissioned officers, the senior for those preparing for the Officers' school. The junior section is divided into three classes; a certificate in the 1st class is necessary for appointment as lance-corporal; one in the 2nd class as corporal or sergeant; and one in the 3rd class as sergeant-major. In every case the men have to pass through a practical course of instruction; and they are not promoted unless they show that they are proficient in this, as well as in their theoretical studies; which comprise reading, writing, arithmetic, artillery, geometry, mechanics, fortification, and drawing. In the engineers a similar plan to that in the artillery is adopted, but instead there are five classes, viz., preparatory class for the rank and file, 1st class, to qualify for the rank of lance-corporal, 2nd class for that of corporal, 3rd class for that of sergeant, and 4th class for that of sergeant-major. Instruction is progressive, beginning in the lowest class with the most elementary subjects, and ending with algebra, geometry, trigonometry, mechanics, fortification, architecture.

Men must have 18 months' service before they can be appointed to the rank of sergeant, except those who have passed the entrance examination into the Cadet College, in which case they can be promoted in 8 months. The instruction in this college is now purely technical, and students are taken from the ranks of the Army; but of course they must have the necessary qualifications to become Officers.

This is the only way in which commissions are obtained in Sweden, for the law is now virtually obsolete which permitted non-commissioned officers of six years' service, two of them as sergeant-major, to be promoted without examination.

Regiments have private chests, out of which Officers and non-commissioned officers are pensioned.

The term of service is six years with the colours and six years in the Landwehr, but the whole Army is not embodied except during the manœuvres.

Norway.

Non-commissioned officers in Norway are divided into two classes —those definitely, and those temporarily, appointed. Both are recruited from the rank and file, if they are qualified for promotion. Those intended for the 2nd class are educated for their position (corporals or sergeants) by a course of instruction, lasting six or ten weeks, at the depôt. Those who aspire to the 1st class have to go through a longer period of instruction; they must remain privates six months, then go through the recruits' school, and then they can be appointed corporals. Afterwards they have to go through a two years' course at the non-commissioned officers' school, and are then eligible for the rank of sergeant. There is one of these schools for each arm of the service in Christiania. According to the manner in which he passes out of the highest class, a student is permitted to compete for admission to the senior division of the War (Officers') School; provided he has at least served for one year as sergeant in the Army, is not over 25 years of age, and has received a sound classical education. By the law of May, 1866, the term of service was fixed at 10 years; 5 of them under the colours, 2 in the Reserve, and 3 in the Landwehr. Substitution was allowed, except in the Landwehr, which, however, could only be called out in case of invasion. In 1876 a new law abolished substitution and the Reserve, the periods of service were also fixed at 7 years for the active Army, and 3 years for the Landwehr. The duty is very light, the troops are only embodied 80 days their first year; and afterwards 30 days a year, is all they have to do.

Those who volunteer for 5 years, and who having completed that period are afterwards free, perform the necessary garrison duties, &c. Non-commissioned officers who have served 20 years are entitled to a pension, and those who have served 6 years on garrison duty, or 12 on general duty, have a claim to a civil appointment.

Belgium.

The Franco-German War in 1870–71 obliged the Belgians to mobilise their forces. Their system, based on that of France, was equally inefficient when it came to be tested practically. Instead of 104,000 men, which were counted upon in 1870, only 72,000 were forthcoming, and out of these 21,000 were *remplaçant*. This was not considered satisfactory, and a mixed commission was appointed to examine into the question of Army reform; but as the panic of war subsided, the

labours of the commission were neglected, and thus, while every Continental nation has re-modelled its military institutions upon the Prussian type, Belgium alone still retains the old form of national defence. The difficulty of change is doubtless due to the commercial enterprise of the people; for those countries who are wedded to industrial pursuits cannot easily be converted into military powers, on account of the high rate of wages. The non-commissioned officers' question in Belgium under the present system is by no means satisfactory, and every day it becomes more serious; indeed, notwithstanding the advantages offered to a young man of good character and moderate talent, it is found very difficult to keep up the standard of those promoted from the ranks, and this is even said to be deteriorating. Under a reformed system, in accordance with modern military ideas, these difficulties would be increased, unless a special plan were adopted to meet them. A complaint which seems generally made against the manner in which non-commissioned officers are lodged, will probably receive attention and be rectified. Old soldiers are not entitled in Belgium to situations in the civil administration of the country after long periods of service, but although this is also recommended by many, it is a question whether such a plan would altogether suit a manufacturing country.

As to the system of military education in Belgium, which has only been perfected in the last few years, there are—

(1.) Regimental schools, often located away from their regiments, in which elementary education is given for one or two years to those likely to become good non-commissioned officers.

(2.) On appointment, they may go through a course of instruction lasting two years, and embracing French, Flemish, arithmetic, algebra (as far as quadratic equations), Euclid, geography, history, field fortification, and drawing. This qualifies for the higher school. If non-commissioned officers do not go through this course, and if they are under 30, they must attend evening classes, to be taught principally elementary geography and history.

(3.) The highest non-commissioned officers' school is that to qualify candidates from the ranks for commissions. This was established in 1871, and the instruction is said to be the minimum required. There is an entrance and a final examination, and men may go up for the latter without going through the whole course.

Promotion from the ranks takes place easily in Belgium, and thus there is sometimes a difficulty in getting active Officers in the higher ranks by *seniority*; moreover, as has been remarked, the standard of Officers thus obtained cannot be maintained high. There are some, therefore, that desire that this manner of rewarding non-commissioned officers should cease.

General Thiébault, in his first triennial report on the military education, laid before the Chambers 3rd June, 1874, says that the higher education in the Army is satisfactory, but "the same cannot be said "of the middle and lower establishments; unfortunately, the good "material is not to be found there." Recruitment of volunteers, he considers, leaves much to be desired, as far as quantity and quality is

concerned, and most non-commissioned officers leave the Army at the expiration of their engagement, in order to take the advantage of more lucrative employment in civil life. It is then difficult to supply the Army with non-commissioned officers; instead, a large number of indifferent character take their place as such, and men who do not possess the necessary qualifications are all that can be got.

Italy.

Italy is more advanced in the solution of the problem of getting non-commissioned officers than any other Military Power. She has developed a system which, although not very long in force, seems to answer; it requires only a few years to perfect it and to bring it into full operation. Italy, it must be remembered, has probably less difficulties to contend with in this question, than other nations who have adopted obligatory military service; the country has no great manufacturing or commercial industries to render the Army such a source of loss as it is elsewhere. The character of the people is not very enterprising, and although many from necessity leave the country to seek work elsewhere, yet the majority if they can get just sufficient to live at home, prefer to remain there. Indeed, in many parts of Italy work is by no means easy to be got, and this of course renders good positions in the Army more popular than they would be where an active trade competed in the labour markets. Comparatively speaking, then, Italy has little difficulty in solving for herself the question of non-commissioned officers; although the good results arrived at by her present system are not altogether due to this, but also to the rules which have been drawn out.

The Italians divide their non-commissioned officers into two classes, the superior, or those who are sergeants and above that rank, and the inferior, or those who are corporals and do not rise higher. Little trouble is taken about the latter; men out of the ranks considered fit, are promoted to these lower grades, and when their period of service is over they retire, without any claim on the State. The superior class, or *Sott'Uffiziali*, properly so called, are procured and rewarded in a very different manner.

All men who wish for promotion must engage to serve for a term lasting eight years (the time as private or corporal being allowed to count). This is called taking the *ferma permanente*, and it lies at the very foundation of the Italian system; there is absolutely no exception to the rule. Owing to this, the State can always reckon upon the service of a sergeant for about six years at least, and as the period of the *ferma* is not reduced should a man lose his stripes, there is every inducement for him to discharge his duty with vigilance, instead of having to spend a weary eight years as a private under the colours.

Men of good conduct, of sufficiently strong constitution, and well up in their work, may re-engage for three years at a time, the Royal Carabineers four times, the rest of the Army three times, provided they have not passed the age of 40 for the former, and 36 for the latter. The first of these re-engagements takes effect after the end of the eight years' *ferma*, but the Minister of War is empowered to allow

the man to enjoy the extra pay which it brings, after six years' service; provided always that the man agrees to serve his extra three years, after the completion of the eight years' service. This induces re-engagement and secures the presence of a good non-commissioned officer with the colours after his legal term is completed. These re-engagements all have extra pay attached to them.

There are several winter schools in the Italian Army for the instruction of the men and non-commissioned officers; an elementary class for those who cannot read and write, a school for those who aspire to be corporals, in which grammar and arithmetic are taught; and a school for such as aspire to be sergeants, in which grammar, arithmetic, elementary geography, and the reading of maps are taught. A sufficiently good class of sergeant was however hardly to be expected from the ranks; there was not sufficient leisure for training them, and it became necessary to organize schools or battalions (squadrons or batteries) of instruction, specially established for the purpose of educating young men as non-commissioned officers. These were founded in 1872–73–74. Three, viz., those at Maddaloni, Asti, and Senigallia for infantry; one at Pignerol for cavalry; two at Pisa and Caserte for field artillery; one at Genoa for garrison artillery; and two at Pisa and Casale for engineers.

Candidates for these schools must—

(1.) Know how to read and write.

(2.) Enlist for 8 years (take the *ferma permanente*).

(3.) Be over 17 years and not more than 26 years old.

(4.) Be unmarried or widower without children.

(5.) Be sufficiently strong and tall.

(6.) Not have been previously rejected for the Army, or punished therein as a bad character.

They must further be provided with a document giving the consent of their father, mother, or guardian to join the school; certificate of birth, and of good conduct from the civil authorities, or from the military if formerly a soldier. On entry they have the pay and uniform of privates, their eight years' service counting from that instant; after six months, if they deserve it, they are promoted to the rank of corporal with the pay. On completion of a year as corporal, they are promoted to sergeant if they are considered fit, and go to their regiments as such. Those who have been kept back are allowed six more months to qualify themselves to receive the sergeant's stripes; but after these 24 months at school they must join their regiments with whatever rank they have attained to. If afterwards they do not show sufficient capacity, or fail to satisfy their superiors by misconduct, they are never promoted, while they are obliged to complete their full eight years in the ranks.

These schools are organized as battalions, squadrons, and batteries, with a full complement of Officers and non-commissioned officers. The instruction given is both practical and theoretical; the latter includes Italian, arithmetic, elementary geography, reading of maps, interior economy, elementary principles of military hygiene, and military law, together with an easy method of teaching recruits how to read;

the former embraces drill, musketry, gymnastics, fencing, &c. Especial care is taken that the pupils should be able to teach and drill others; for this purpose they are accustomed to use their voices to drill squads, and to go through all the necessary explanations in the Army Regulations. The great object is to train instructors, men who have a thorough knowledge themselves of everything connected with the Service, and who can impart that knowledge to others. As a rule they are quite young, between 17 and 19 years old, and most of them succeed in passing their examinations to become corporals in six months, and sergeants in eighteen months. In consequence they enter their regiments for the first time younger even than those they are called on to command: obligatory service commences at 20. The inconvenience of this has already been remarked upon. In order, however, to prevent the Army being overrun with too many young non-commissioned officers, which the resources of the present system would necessitate for the next few years, the Government has created the rank of corporal-major, given to the best corporals. They are really sergeants, although they have not taken the *ferma permanente*, and are distinguished by red braid on the arm instead of silver stripes.

Besides their ordinary pay, sergeants receive from the date of their promotion, a special extra pay (*caposoldo*) of 150 lire[1] per year. Also during each re-engagement an additional annual sum of another 150 lire. Thus if a non-commissioned officer signifies his intention to re-engage, as we have seen he can do, after six years' service, his extra allowances per year amount to—

At the school	Nil.
When promoted sergeant	150 lire.
1st re-engagement from beginning of 7th year to end of 11th year	300 „
2nd re-engagement from beginning of 12th year to end of 14th year	450 „
3rd re-engagement from beginning of 15th year to end of 17th year	600 „
4th (if in Royal Carabineers) re-engagement from beginning of 18th year to end of 20th year	750 „

On leaving the Army he receives coupons on the National Funds, yielding an income equal to $\frac{1}{5}$ths of the extra pay enjoyed on account of re-engagements, but not from the special allowance called *caposoldo*, so that on retiring after 11 years' service, this amounts to 120 lire, after 14 years to 240 lire, after 17 years to 360 lire, and after 20 years (for the Royal Carabineers only) to 480 lire per annum; should he take his discharge during the course of one of the above terms of re-engagements, the amount of coupons are calculated only to give him $\frac{4}{5}$ths of the re-engaged pay, for the periods he has completed; thus, in leaving before the completion of his 17th year, he is only entitled to an income of 240 lire. Those, however, who are obliged to leave, from any illness caused by the Service, are permitted to count their unfinished period as if completed.

[1] A silver lire is equal to a franc.

By this means pensions cease to become chargeable to the State, and pension offices are therefore dispensed with; moreover, the holders of these incomes can draw them or sell out of the Funds if they wish to raise a small capital for present use, and these advantages are secured them without burdening the War Department with extra business or trouble. Again, if a non-commissioned officer dies when with the colours, his heirs receive coupons giving an income equal to the full amount of his re-engaged extra pay (not *caposoldo*), and if his death was due to the Service, the broken period of re-engagement is calculated as completed.

After 17 years' service (20 in Royal Carabineers) non-commissioned officers may remain on, if still fit for work: they cannot re-engage, or receive additional extra allowances, but they serve on for pensions. After 25 years' service (if 45 years' old) these are fixed at 500 lire per year for sergeant-majors, 415 lire for sergeants; afterwards, each year, or campaign, adds 10 lire to it, until it reaches a maximum of 725 lire for sergeant-majors, and 565 lire for others, which sums can be obtained after 40 years' service.

After 12 years' service non-commissioned officers who take their discharge are helped in obtaining civil posts. These are more especially taken care of by the War Administration, and are eligible to be named as Sub-Lieutenants in the provincial militia. Generals in command of Army Corps are by a ministerial order of December, 1871, told that a portion of their duty is to get those non-commissioned officers who have served faithfully for twelve years, civil employments, not only in the military administration, but in the railways, telegraphs, &c. In February, 1872, the Minister of Public Works also drew attention to the necessity of employing them on the railways. There appears to be no absolute right to a situation, although a Parliamentary Committee wished to make it so; everything, however, is done to facilitate men getting these employments, and from January, 1873, to May, 1874, 1,035 were so employed.

Non-commissioned officers are treated very well and with great consideration; and finally, they cannot lose their rank without being tried by a court-martial (*Commissione di Disciplina*), composed of a Lieut.-Colonel or Major as President, and four members, the finding of which must be confirmed by the Lieut.-General commanding the division.

Re-engaged non-commissioned officers lose the extra pay attached to the actual period they are completing, when condemned by a court-martial constituted as above. They may, however, leave the Service as soon as their eight years is finished. They retain a right to the income due from former periods of re-engagement (if any); except when deserters, or when condemned to prison by criminal procedure, or by sentence of a military court, in which cases their rights are suspended until they have finished the punishment inflicted.

Those non-commissioned officers who retire after their eight years' service pass at once into the territorial army; on mobilization, therefore, there would be none in reserve to call up to fill the 4,000 vacancies which would occur. This deficiency is made good by those one-year volunteers who obtain the grade of Reserve sergeant. Each year

there are about 400 of them, or 3,000 in the nine classes of the mobilised army. There will probably be more in future, for the permission to get transferred from the first to the second class of the contingent is now done away with (since 1st July, 1876), and there should be more one-year volunteers in consequence.

Italian non-commissioned officers are often promoted to the rank of Officers. A school at Modena is established expressly for this purpose, and a certain number of men are selected each year by the Colonels of regiments to go up for the entrance examination; these candidates must have at least eighteen months' service as sergeant with the colours. If they pass, they go to Modena for another eighteen months, and after a second examination obtain a commission as Sub-Lieutenant. By taking advantage of this regulation, a young man may enter a battalion of instruction at 17 years of age, pass into his regiment as sergeant, and after serving as such for a year and a half, qualify himself for the school at Modena at 20, and finally become an Officer at $21\frac{1}{2}$ years old. The subsequent promotion of these men will not be rapid, as their education cannot naturally be up to the point it should be, and Captain in the Train will probably be the highest rank to which they can attain. The results, however, of this system cannot yet be ascertained, since it has only been begun a short time ago. It is evidently an expensive process for obtaining Officers; the State having to provide the whole education of the candidates, together with their pay and maintenance for four years and a half—the eighteen months in the regiment can hardly reckon as efficient service.

The ordinary pay is provided for by the War Budget, but the special extra pay (*caposoldo*), and re-engaged pay, are met by funds in the military chest. This is managed by a committee, consisting of eight members, who choose their own president; viz., two senators and two deputies, elected by their respective chambers, two financial officers, and two general officers, nominated by the president of the court to which they belong, and by the War Minister respectively. The committee changes with the Government. The funds used to be obtained from two sources (1) from the fines of those who paid to be transferred from the first to the second class of the annual contingent, and (2) of those who served as one-year volunteers. Since 1st July, 1876, no one can exchange military duty for money, and the fines of one year volunteers (viz., 1,600 lire for cavalry, 1,200 lire for infantry) are consequently now the sole source of income. It is calculated that there are annually about 4,000 one-year volunteers, and that 8 per cent. enter the cavalry. Thus

By 320 one-year volunteers for cavalry at 1,600 lire	512,000
And 3,680 one-year volunteers for infantry at 12,000 lire.	4,416,000
Or annually.....	Lire 4,928,000

According to statistics there are 11,650 non-commissioned officers who receive special extra pay (*caposoldo*), and this at 150 lire each, amounts to 1,747,500 lire, which leaves a sum of 3,180,500 lire every year for

re-engaged pay. Should this source of income not be sufficient, there is still the means open for procuring more, by levying money from those who cannot serve in person—like the old Bavarian *Wehrgeld*.

Such are a few of the leading features of the Italian system for the supply of non-commissioned officers, and it is found to give a sufficient quantity for the requirements of the Army. Of course time is needed to give thorough proof of its value, and certain modifications will probably be necessary in its details. Its broad principles, however, are sufficiently striking and important to make them worth the serious consideration of those countries who are perplexed with the difficulties of the question. These principles seem to be—

(1.) Engagement for eight years for all who take the stripes.

(2.) Inducements for re-engagement, viz., an increasing extra pay, and a bounty on completion of service given in a convenient form to the recipient, and in a manner to lighten the duties of the War Department.

(3.) Recognition of the principle that those who cannot serve in person, when universal conscription without exemption is the law of the land, shall be obliged if necessary to pay a tax for the support of the Army; this fund to be devoted to the use of the corps of non-commissioned officers.

It will be useful to state, before finishing this subject, the different strengths in which non-commissioned officers are distributed in the Armies of Europe. The best idea of their relative importance will be got by looking at the organization of a company and also that of a regiment. The latter is the largest unit in which non-commissioned officers appear in the combatant strength of an Army (in Brigades and Divisions those employed at head quarters being usually clerks, &c.); while the former, in continental Armies, is a tactical unit of great importance. In the following lists, the cadets are placed separately; the sergeant-majors and sergeants are classed as non-commissioned officers, properly so called; and finally also corporals and lance-corporals are put by themselves. The importance of these ranks probably varies in different Armies, but they are placed as above for the purpose of comparison.

England.

A battalion on a war strength contains:—

3 Field Officers, 25 Officers, 49 non-commissioned officers, 40 corporals, and 960 privates.

Germany.

Company peace footing:—

4 Officers, 1 *fähnerich*, 6 non-commissioned officers, 20 corporals and lance-corporals, and 106 men.

Company war footing:—

5 Officers, 1 *fähnerich*, 6 non-commissioned officers, 37 corporals and lance-corporals, and 201 men.

A regiment is composed of 3 battalions of 4 companies each. The regimental and battalion staff consist of:—

5 Field Officers, 4 Officers, and 4 non-commissioned officers.

Regiment on a war footing is (not counting non-combatants) :—

5 Field Officers, 64 Officers, 12 *fähnerichs*, 76 non-commissioned officers, 444 corporals and lance-corporals, and 2,288 men.

France.

Company peace footing :—

3 Officers, 6 non-commissioned officers, 8 corporals, 66 men.

Company war footing :—

4 Officers, 10 non-commissioned officers, 17 corporals, 224 men.

A regiment is composed of 4 battalions of 4 companies each and 2 depôt companies, the latter having the same cadres as a company on a peace footing, but 170 men instead of 66. The regimental and battalion staff consist of :—

7 Field Officers, 5 Officers, and 4 non-commissioned officers (*adjudants*).

Regiment on a war footing is (not counting non-combatants) :—

7 Field Officers, 69 Officers, 148 non-commissioned officers, 256 corporals, and 3,584 men; and a depôt of 12 Officers, 12 non-commissioned officers, 16 corporals, and 340 men.

Austria.

Company peace footing :—

3 Officers, 1 cadet, 5 non-commissioned officers, 10 corporals and lance-corporals, and 70 men.

Company war footing :—

4 Officers, 1 cadet, 5 non-commissioned officers, 30 corporals and lance-corporals, and 180 men.

An Austrian battalion has 4 companies; and an infantry regiment in war time is composed of a field regiment, a reserve regiment (or 5 field battalions) and one *ergänzung* battalion (which has no cadet). The regimental staff is composed of 8 Field Officers, 8 Officers, and 11 non-commissioned officers.

Regiment on a war footing is (not counting non-combatants) :—

8 Field Officers, 108 Officers, 20 cadets, 125 non-commissioned officers, 750 corporals and lance-corporals, and 4,500 men.

Russia.

Company peace footing :—

3 Officers, 1 younker, 9 non-commissioned officers, 16 corporals, 80 men, and 4 reserve men without arms.

Company war footing :—

4 Officers, 1 younker, 17 non-commissioned officers, 20 corporals, 148 men, and 12 reserve men without arms.

Battalion staff, 1 Field Officer and 1 Officer.

Regimental staff, 5 Field Officers and 1 Officer.

A regiment consists of either 3 or 4 battalions, and each of these is composed of 4 field companies and 1 rifle company.

Regiment of 3 battalions on a war footing is (not counting non-combatants) :—

8 Field Officers, 64 Officers, 15 younkers, 255 non-commissioned officers, 300 corporals, 2,220 men, and 180 reserve men without arms.

Italy.

Company peace footing :—

4 Officers, 7 non-commissioned officers (2 of these corporal-majors), 13 corporals and lance-corporals, and 73 men.

Company peace footing :—

5 Officers, 13 non-commissioned officers (4 of these corporal-majors), 33 corporals and lance-corporals, and 145 men.

A regiment consists of 3 battalions of 4 companies each; the regimental and battalion staff consist of :—

5 Field Officers, 4 Officers, 10 non-commissioned officers (of which 3 are corporal-majors) and 1 corporal.

Regiment on a war strength is (not counting non-combatants) :—

5 Field Officers, 64 Officers, 166 non-commissioned officers, 327 corporals and lance-corporals, and 1,740 men.

ESTIMATES FOR THE ITALIAN NAVY FOR 1878, AND ACCOUNT OF THE NEW IRONCLAD "ITALIA," BUILDING AT CASTELLAMARE.

(Translated from the "Révue Maritime et Coloniale.")

THE provincial budget for the year 1878 has been already presented to Parliament by the Government of Italy. The preliminary statement puts forward figures not very different from those of last year. As to the Navy, the proposals are presented in the following manner :—

	Lire.
The total estimate, as voted in the past year	41,630,778
Increase for 1878	2,315,329
Total	43,946,107 = £1,750,000.

On one side the reconstruction of the *matériel* of the Navy, on the other a larger number of ships commissioned and an improvement in the position of the petty officers, have made an increase in the estimates appear necessary.

The Naples newspaper, *Il Piccolo Giornale Della Sera*, of November 5th, contains some information regarding the new ironclad, the "Italia," on the stocks at Castellamare, which has appeared to us of sufficient interest to be brought to the knowledge of our readers.

This ironclad, the largest of all the ships of war in the world, has the following dimensions approximately :—

Length	393·7	feet.
Beam	72·0	„
Mean draught	27·9	„
Depth, upper deck to keel	49·2	„
Displacement, load	13,000	tons.
Weight of the hull, on launching	5,000	„

The hull is so constructed as to constitute a sort of gigantic armed girder. A double bottom 302 feet long, 65 feet wide, and $3\frac{1}{4}$ feet deep, divided into cells, protects the lower parts of the ship against the effect of torpedoes. Two longitudinal water-tight bulkheads run from the fore part to the after part of the ship, so as to form, in horizontal projection, 53 large compartments (40 above the double bottom, 3 abaft, and 10 forward). These compartments, in turn, are divided from top to bottom by four watertight decks:—

1. The deck, plated with $2\frac{1}{2}$ inches of armour, situated about $8\frac{1}{4}$ feet below the water-line, presenting a considerable curve ($3\frac{1}{4}$ feet).

2. A deck, forming a hollow girder, 4 feet 10 inches above the water-line. Between these two decks are compartments filled with cork; to this space the armoured belt exactly corresponds, but the Italian paper does not mention side armour.

3. The battery deck, 14 feet above the water-line.

4. The upper deck, 21 feet above it.

On the upper deck is fixed the armoured citadel, oval in form and 6 feet 6 inches high, the axis of this oval makes an angle of about 20° with the keel; the guns fire *en barbette* and are placed symmetrically at the extremities of the citadel. The space comprised between the second deck and the upper deck does not seem to be armoured. The funnels and the passages for the supply of powder only are surrounded by plated casings, starting from the armoured deck; but whilst the first have only a moderate height, the others are carried up to the citadel. The vessel is to be propelled by two screws of 19 feet diameter; each of them being worked by an engine of six cylinders. The boilers will be twenty-six in number. The power expected is to be 18,000 horse-power, and it is hoped that a speed of 16 knots may be attained.

Without attaching over importance to information collected in the communication of a newspaper reporter, it is not beside the question to remark that the figures of the principal dimensions agree very fairly with the information published concerning the first constructed large Italian ironclads, the "Duilio" and the "Dandolo." The "Italia" ought to be a vessel having nearly the same general fineness of form. If we calculate, by analogy with the former vessels, the surface of her midship section, we shall find it to be about 473·13 feet. From this, then, it would result, that in order to attain a speed of 16 knots, there should be exerted a power of about 125 horse-power per square metre of the midship section; though it may generally be admitted that from 90 to 100 horse-power is more than sufficient. Moreover, supposing that the boilers have each three furnaces, and that every one of them develops 200 horse-power, which would be a

high maximum, we reach a figure of 15,600 horse-power. There is ground, therefore, for these two reasons, to consider the power mentioned as somewhat exaggerated.

The armament is not mentioned, but it would seem probable that it will be composed of four guns of 100 tons, mounted in pairs on turntables. The form adopted of a casemate surrounding the two turntables, instead of two separate turrets, as on board the "Dandolo," has for its object the diminution of the development, and, consequently, of the weight of such a surrounding.

It seems strange that a protected deck placed below the water-line and running throughout the entire length of the ship should have been adopted. That, where there is no side armour, before and abaft, the armoured deck should be placed below the dividing compartments, is a necessity; but where there is the protection of an armoured belt, it is evident that the plated deck ought to be carried to the upper part of that belt, instead of creating a sort of reservoir, in which projectiles striking in a plunging direction must necessarily explode.

It is very probable that these early *data* will be modified hereafter, but they are not the less interesting as characteristics of the new steps made in the path of building gigantic ships. It is very possible that this will be the last, and that, instead of seeking to produce marine Colossi, a return will be made—in displacements of 8,000—to the dimensions of manageable ships, and to a cost such that it will not be necessary to stake our total resources on one or two elements of a problematical success.

(Signed) P. DISTERE,
Sous Ingénieur de la Marine.

FLOATING OF THE STRANDED FRENCH MAN-OF-WAR "ESCOPETTE."

From the *Moniteur de la Flotte* of February 10th.

We announced in a recent issue the floating of the gunboat "Escopette," belonging to the naval division in Indo-China, which had grounded by touching an unknown rock on her way to Baria. The work of saving her has been accomplished with devotion, energy, and perseverance.

The operation was divided into two parts. From the 29th of October to the 6th of November, the object was to get the chains, intended to lift the gunboat, into place. This work was rendered very arduous by the nature of the bottom, a soft mud, in which the "Escopette" was imbedded, and by the necessity of working at a particular time of tide, however great the heat of the sun. The depth of water was 6½ fathoms. It was not till the 16th of November that the second portion of the work could be taken in hand: it was to raise the wreck and transport it to a hard bottom dry at low water.

On the 18th was reached, in a depth of $5\frac{1}{2}$ fathoms, the entrance of an *arroyo*, hitherto unsurveyed, in which M. Havard, Captain of the "Framée," had marked a bank of hard sand, which uncovered at low water, and on which it was necessary to place the "Escopette" at first, in order to temporarily stop the leaks, and put her in a condition to be towed to Saïgon without the help of lighters. The distance intervening between the starting point and this bank was a mile.

It was only on the 21st, after many difficulties, that they were able to place the "Escopette" on the top of the sand-bank. Two engineers of the "Framée," the 2nd class engineer, Journaux, and the stoker-mechanic, Pascal, took steps to stop the leak. It was necessary, to achieve this result, to attach to the hull close to the keel, two plates of sheet-iron, each about $5\frac{1}{2}$ feet long, kept in place by a hundred bolts, compressing coverings of woollen stuff. As soon as the fall of the water allowed the work to be resumed, these two men began without delay, one outside in the muddy water up to his waist, the other inside with his head and body under the boilers; both worked with admirable energy and persistence.

On the 26th, the gunboat floated without making any water, and arrived at Saïgon on the 27th, at 7 o'clock in the evening, her hull being perfectly dry. Although having often worked during the hottest hours of the day, occasionally without any shelter from the sun and always in the muddy emanations from the *arroyo*, none of the men who took part in getting the vessel afloat have been ill. This result is due to the excellent superintendence of the men by Lieutenants Chassérian and Havard, who were in charge. The engineers Journaux and Pascal have obtained special promotion in their class, and a communication expressing the satisfaction of the Minister of Marine has been addressed to the Officers and men who were engaged in the work.

THE RUSSIAN ESTABLISHMENT AT VLADIVOSTOCK.

(Translated from the *Rivista Marittima.*)

FROM a report made by the distinguished Cavaliere Canevaro, commanding the "Cristoforo Colombo," to his Excellency the Minister of Marine, we have extracted a portion which has a general interest, and we believe that in publishing it we are conferring upon our readers a real present.

"Simonoseki, 31 August, 1877.

"Russia has made an important acquisition on the coast of Man-
"chouria, ceded to her by China a few years back. Although the
"Czar already possessed the whole eastern coast of Siberia, his
"dominion over the inhabitants of the seashore was only exhibited in
"several military establishments like Petro-Paulosk and Nicholaievsk,
"and a few others of inferior importance, which had no vitality of
"their own, and cost the Central Government a great deal without

"being capable of ever rendering the services demanded by the "Russian Navy, on account of the serious inconveniences, due to "climate and the hydrographical position of the places selected. "In possession of Manchouria, the Russians chose Vladivostock as a "site for a colony, and in order to make there a respectable naval "establishment: for four years they worked at it with such activity "that they have made a settlement of from seven to eight thousand "inhabitants arise, in which are being concentrated the resources "which had previously been established at other stations.

"In spite of their goodwill and the money expended, this new "station is still far from being a colony properly so called, from "having a naval arsenal, and from being suitably fortified with due "regard to the object kept in view. It is difficult to obtain statistical "*data* concerning the population and the resources of the settlement, "because of the precautions taken against it and the difficulties in the "way of settling there experienced by foreigners. The extension of "the colony is solely due to the impulse of the Government, "principally by means of convicts of both sexes from Siberia, to "whom, as a reward for good conduct, are let dwellings and given "land to cultivate. There are, however, several Germans and English "who carry on a trade with Europe in furs, also, a few Frenchmen "and one Italian who are innkeepers. The greater part of the "business is carried on by Chinese with Shanghai, in small numbers, "however, as they are ill adapted to bear the excessive strictness of "the authorities.

"It is asserted that in the neighbourhood there are gold mines, but "the results are a secret, they being worked on behalf of the Govern- "ment. From a naval point of view the harbour is magnificent, as it "is sheltered from all winds, can be easily defended, and is accessible "to ships of every class; however, at present there are neither basins "nor building slips, and there only exist some storehouses and depôts "of *matériel;* but the locality is perfectly fitted for the erection of a "good naval establishment. As a military port Vladivostock can be "defended on the side of the sea by a few batteries and a few tor- "pedoes, the more easily as during the winter no one can approach it, "because the water within the harbour and in the bay outside freezes "to a distance of several miles. On the land side it can be effectively "defended, on account of the favourable disposition of the hills. "Still, in case of war, the colony would be completely isolated, as its "easiest communications are by sea with China, Japan, and the "United States of America; whilst by land it is so remote from the "centre of Russia that assistance could not reach it across Siberia, "for the postal service takes three months to carry a letter to St. "Petersburg.

"From a comparison of these particulars, it is certain that no great "idea must be formed of Vladivostock, but still its importance is "manifest, if we consider that in a few more years Russia can make "there an imposing naval station, which, in case of war, may furnish "ships destined to cruise in the Pacific, and more especially in the "Japan and China seas, to oppose European influences. At the

"present time there are in the harbour six ships of war suitable for "long cruises. They are fitted out to perform the same duty as that "performed by the 'Alabama' during the American War of "Secession. The Russian Naval Officers count much on them and "have already completely organized their crews.

"In recapitulation, I would say to your Excellency that, although "Vladivostock has a relatively temperate and healthy climate, fertile "and rich soil, and an admirable hydrographical situation on the "Japan Sea, it seems not likely to soon become an important part for "population and commerce, the Russian system of colonization not "being favourable to ventures of such a nature. But, at the same "time, this advanced military post of Russia may soon be a menace "to the interests of the other nations of Europe in these distant parts "of Asia, and in a few years may become a danger."

NOTICES OF BOOKS.

A Manual of Naval Architecture, for the use of Officers of the Royal Navy, Officers of the Mercantile Marine, Shipbuilders, and Shipowners. By W. H. White, Assistant-Constructor, R.N. London: John Murray, 1877. 1 Vol. Size 9 in. × 6 in. × 2 in. Pp. 664. Weight, 3 lbs. Price, 24*s*.

In this manual we have a work of great value, and we may safely say that the author has to a very full extent fulfilled the object that we are told in his preface he had in undertaking its publication.

Undoubtedly, the book, written as it is in language and phraseology that can be easily understood by the uninitiated in the technicalities of marine architecture, is exactly what is required by naval Officers and others interested in the general principles of scientific shipbuilding.

Mr. White, as lecturer and instructor at the Royal Naval College, Greenwich, in this important branch of naval science, is in a position to gather from his audience and pupils the nature of information that is sought by naval men; the language best suited for explaining his subject to them; and also the amount and description of knowledge it is necessary that Officers of the Royal Navy should possess, so as to place them in the position of being able to supply useful and practical information to naval architects for the furtherance of the science of shipbuilding. In his office of Assistant-Constructor, Mr. White has access to all the reports and documents that have passed into the hands of the department, on his subject. The author has made good use of these advantageous positions, and with a skilful pen has produced a work that we can strongly recommend to the notice and use of the naval world.

In briefly tracing the principal features of the "Manual," we notice that the first four chapters are full of useful and practical information; that the chapter following these, on "Deep Sea Waves," is interesting but almost entirely theoretical, and treats of a subject of which comparatively little or nothing is known; Chapter VI is in the same strain, and is followed by another that can hardly be considered more

than a description of how the search for knowledge on the questions of wave motion, and the oscillations occasioned by moving water acting on a floating body, may be best conducted. We now come to three most practical chapters, on the strain experienced by the structural strength of, and the materials for, building ships; but of the whole work, perhaps Chapter XI, on the "Resistance of Ships," contains the most valuable and interesting information. Mr. Froude is here freely quoted, and it is in this chapter that the lines of ships with a view to speed are treated, as also the various resistances offered in opposition to a ship's progress; so important are the questions involved in this part of the work, that we would suggest to Mr. White the desirability of enlarging on them in a future edition, should he find leisure to do so. The remainder of the book, dwelling on the propulsion and steering of vessels, is full of useful and important information. Throughout his work the author's strong point is the concise, impartial, and comprehensive manner in which he treats and compares the different matters referred to. An additional recommendation is to be found in the admirable type in which the volume is published, and the numerous, lucid, and well-designed diagrams explanatory of the subject discussed, with which its pages abound.

We may say, with all honesty, that the gratitude of the Navy is due to Mr. White for supplying such a valuable addition to its literature; and that we shall ever be ready to welcome the appearance of his works, when written with the same degree of ability and good intention.

G. H. N.

The War Ships of Europe; being the substance of a work recently published in America, by Chief Engineer KING, U.S.N., revised and corrected throughout, with additional notes, by an English Naval Architect. Portsmouth: Griffin and Co., 1878. Pp. 338. Size 5¼ in. × 7¾ in. Weight 20 oz. Price 10*s.* 6*d.*

IN the last number of the Journal we noticed a book on the war fleets of the world—*Les Navires de Guerre les plus recents*—by a French Naval Constructor, M. Marchal. It is now our good fortune to be able to call attention to a similar and even more important work on the same subject written in our own language. The publication of this book may be taken as evidence of the increasing interest which in this country, no less than abroad, is now paid to naval affairs. Unfortunately we are not yet able to bring under the notice of our readers works of this nature which we owe solely to the pens of our own countrymen; we still have to depend for information, for compendious information at all events, concerning even the ships of our own Navy, upon the labours of foreigners. Still this carries with it a certain consolation; we are more likely to obtain from them an unprejudiced view of the real state of our *matériel* and its comparative value with those of other nations. No foreign observer is likely to seduce us into over-estimating the qualities of the vessels which we do possess; and, by relying upon his judgment, we are not very likely to commit the fault of indulging in an undue opinion of our own superiority.

In the book under review, we have a complete cyclopœdia of the effective strength in ships of all the navies of Europe. Few important ships, perhaps no important class of ships, is altogether omitted from notice in this singularly interesting book. With the exception of the newly designed, and we believe already laid-down Italian vessels, "Italia" and "Lepanto," a clear and full description of all the most powerful components of European navies is offered to the reader. Mr. King was sent to Europe in the summer of 1875, by the Secretary of the United States' Navy, and was steadily employed for a year in visiting the dockyards and naval ports of various countries, and collecting information on naval matters. The book, therefore, is an official document; a report to the Minister of the result of Mr. King's inquiries. It has thus all the gravity and accuracy which we should expect from such a document, and is rendered all the more important by being the production of a professional expert. Its value, we need hardly remark, has been very considerably heightened, in the present edition, by the editor being an English Naval Architect, whose opinion, it is not difficult to perceive, is quite as worthy of consideration as that of Mr. King himself, and whose opportunities have enabled him to correct any

errors in the original report. A glance over the list of contents will show how varied they are. The work does not deal exclusively with ships, armoured or unarmoured. There are chapters devoted to the consideration of compound engines, marine boilers, sea valves and cocks, offensive torpedo warfare, British naval dockyards, the Royal Naval College, besides those which deal with the fleets of the naval powers of Europe. At the end is an extensive appendix, in which we find detailed information concerning Her Majesty's ship "Devastation," and other ships of the Royal Navy, and lists and dimensions of the ironclads belonging to several foreign countries. To give an idea of the fulness of some of the descriptions we have only to state that the "Inflexible," "Devastation," "Thunderer," and "Dreadnought," have each a chapter to themselves, whilst another chapter is occupied with a discussion of the cost of building armoured ships for the British service. It must not be supposed that the book is a mere report on the different vessels which fly the national flags of Europe, simply giving an account of their number and a description of the system of their construction. Written, as we have before said, by a professional expert, it is interspersed with critical remarks of considerable and striking acuteness, which those who read will do well to lay to heart. Remarks of a similar kind are occasionally to be found in the notes added by the editor. This naturally lends to it additional interest, and it will not be necessary to say that it is thereby rendered very much more valuable. The observations of the policy of the French and of the Austrian constructive authorities are eminently deserving of attention, as also are those (see p. 184) on the Russian fleet. With this book in his possession, nearly every naval Officer has the means at hand of finding out almost everything about the ship to which he belongs, as far as her design is concerned. He may indeed, in many cases, go much farther; her qualities, her cost, and even the policy which dictated her design will be explained for him. More than that, he will be able to learn very nearly as much about the ships of those powers with whose flag during his service afloat he is constantly falling in. This information, as said above, will be conveyed to him on unquestionable authority and, we may add, with great clearness. The book is well illustrated, and besides is handy in size, well printed, and altogether excellently got up. We consider it highly deserving of the notice of naval Officers.

C. K. G. B.

A Manual of Telegraph Construction. By JOHN CHRISTIE DOUGLAS. Published with the approval of the Director-General of Telegraphs in India. London: Griffin and Co., 1877. Size 7½ in. × 5½ in. × 2 in. Pp. 491. Weight 1¾ lbs. Price 15*s.*

THE existing works on telegraphy touch very slightly on the mechanical principles on which telegraph structures should be designed, so as to secure the utmost durability with the least expenditure.

Mr. Douglas ably supplies this want. He has collected a great mass of information from many sources, and gives numerous formulæ.

In the chapter on "The Theory of Submersion of Submarine Cables," an error is pointed out in Messrs. Clarke and Sabine's "Table of the tension of Cables when "payed out at different angles," and the author shows that a cable does not hang in a catenary during that operation.

Part II is devoted to a description of materials and the methods of preserving and preparing them for use; methods are giving for constructing lofty masts to carry wires across rivers. Such structures are not in favour in this country, but are largely used abroad.

In Part III we have a full description of the method of estimating for and constructing overhead, underground, and submarine telegraph lines, and in an appendix a very brief account of "The result of the experience gained during the Abyssinian, "Ashantee, and Looshai expeditions, the Franco-German war, and the autumn "manœuvres," in the erection of temporary lines. One of these is said to be, that the arrangements for paying-out and picking up the wire at a trot by the use of horses

and mechanical appliances are practically useless; this hardly agrees with the experience of our Field Telegraph Troop; but another opinion "that it is better to "use full sized instruments than small portable ones" for military purposes, will be endorsed by practical telegraphers.

In conclusion it must be noted that although Mr. Douglas only professes to deal with principles, nevertheless the practical value of his book would be much higher if it were more fully illustrated with diagrams, the application of the formulæ shown by examples, and much irrelevant matter omitted.

H. F. T.

Dictionary for the Pocket. French-English and English-French. By JOHN BELLOWS. 2nd edition. London: Trübner and Co., Ludgate Hill. 1877. Price 10*s.* 6*d.* $4\frac{3}{4}$ in. × $3\frac{1}{4}$ in. × $\frac{3}{4}$ in. Weight under 6 oz.

THIS is an excellent and complete pocket dictionary; the plan on which it is constructed is, so far as we know, novel. The book contains besides the mere vocabulary a fund of valuable information, and it is far superior in every way to the ordinary run of pocket dictionaries; it is remarkable not only for the amount of matter contained within its pages, but also for the ingenuity displayed in arranging this matter satisfactorily. The book is well worth its price.

Les Machines Infernales dans la Guerre de Campagne. Application de la Théorie des Mines. Par H. WAUVERMANS, Lieutenant-Colonel Commandant du Génie de la Ville d'Anvers. Deuxième edition. Bruxelles: Libraire Militaire Muquardt. 1876. Pp. 164. Size $6\frac{1}{2}$ in. × $4\frac{1}{2}$ in. × $\frac{3}{4}$ in. Weight 9 oz.

THE first three chapters are rather interesting to the general reader than useful to the student, Chapters I and II giving a short history of the progress of land and "submarine" mining, and Chapter III treating of the different modes of firing charges (whether by powder, hose, or electric fuses) in a cursory manner.

Chapter IV is well worth reading. It discusses the theory of the action of land mines, and gives practical rules for determining the charges, forms of crater, radius of indirect effect, &c., whether for ordinary, undercharged, or overcharged mines. From a consideration of the proportion of the charge expended without useful effect in the different cases, the author evolves a general formula embracing all the above classes of mines. It is understood that this formula has been tested practically with good results; it will, therefore, be interesting to those who have been accustomed to work with independent formulæ for each variation in the form of the crater.

At the end of the chapter there come a few notes on the use of detonating substances for the above purpose, but the author admits the want of experience therein, apparently, however, agreeing with the general judgment that for mining proper gunpowder is preferable.

Chapter V is on concealed charges, giving a general description of a large number of methods of firing, either automatically or at will. The information in this chapter is rather in the shape of "hints" than in a working form.

Chapter VI discusses at length the charges, ranges, and construction of different forms of fougasses.

Chapter VII is on petards, and is chiefly historical, but gives a few useful examples of their application.

Chapter VIII treats of the miscellaneous employment of explosives, the examples given being chiefly of the class known as hasty demolitions. Alternative rules for the employment of gunpowder and dynamite are given; the latter substance would doubtless be useful in cases where it alone was procurable, but they seem to indicate that dynamite is inferior in power for these purposes to the gun-cotton employed in the English service.

R. Y. A.

On the Supply, Care, and Repair of Artillery Material, including Small Arms and Ammunition for Canadian Militia. By Captain OSCAR PRÉVOST. Pamphlet. Pp. 58. Quebec, 1877.

THIS is an Essay, written for the Medal given by the Governor-General of Canada. It has received honourable mention. It is a very creditable production, and the writer has evidently carefully studied his subject.

Tactical Examples. By HUGO HELVIG, Major on the Royal Bavarian General Staff. Vol. II. "The Regiment and Brigade." Translated by Colonel Sir Lumley Graham, Bart. C. Kegan Paul and Co. London, 1878. Size 9″ × 6″ × 1″. Pp. 127. Weight under 1½ lbs. Price 10*s.* 6*d.*

THE appearance of this volume is singularly well timed, as the period of exercise in Minor Tactics is just commencing at our principal military stations. The example contains illustrations of the working of the three arms. The design of the whole work was explained in No. 93 of the Journal.

H.

The Armenian Campaign. A Diary of the Campaign of 1877 in Armenia and Koordistan. By CHARLES WILLIAMS. 1 vol. London: C. Kegan Paul and Co., 1878. Price 10*s.* 6*d.* Size 8″ × 5½″ × 1½″. Pp. 336. Weight under 1¾ lb.

Armenia and the Campaign of 1877. By C. B. NORMAN, late Special Correspondent of the *Times* at the seat of war. 1 vol. London: Cassell, Petter, and Galpin, 1878. Price 21*s.* Size 8¾″ × 6″ × 2″. Pp. 484. Weight under 2 lbs.

The War Correspondence of the Daily News. Second edition, containing a full description of the taking of Kars. 1 vol. London: Macmillan and Co., 1878. Price 10*s.* 6*d.* Size 7¾″ × 5½″ × 1¼″. Pp. 643. Weight under 1¾ lb.

The Narrative of an Expelled Correspondent. By FREDERICK BOYLE. 1 vol. London: Bentley and Son, New Burlington Street, 1877. Price 14*s.* Size 9″ × 6″ × 1½″. Pp. 424. Weight under 2¼ lbs.

IF we cannot hope to obtain with regard to the late campaign anything approaching in completeness and accuracy the German official account of the Franco-German war, it is nevertheless probable that at a future time we shall receive from some nation whose military representatives at the theatre of hostilities were more welcome than our own, some comprehensive and authentic history of this important struggle. It is possible that the Russian Staff, fired by emulation of its neighbour, may itself publish the desired information. Meanwhile we must avail ourselves of the valuable stores provided by the energy, industry, and intelligence of newspaper correspondents. The four books above given are, so far as we are aware, the only collected series of correspondence at present published. In studying the contents of these books, it is well to bear in mind the caution candidly given by one of the writers, Mr. Williams.

Mr. Williams frankly says: "No pretence, it may serve some misconception to "say, is made at impartiality, which, however desirable for journalists commenting "at home upon the progress of events, is virtually unattainable by correspondents "recording the succession of those events among all the excitement and all the "myriad influences of life in a camp.

"But it may be doubted whether it is either the duty or in the power of a cor-

" respondent, mingling daily and hourly with soldiers fighting for the integrity and " independence of their nation, for their 'hearths and homes,' to preserve that calm " balance of mind which it is the duty of the leader-writer, the editor, and the statesman " to endeavour to cultivate; consciously or unconsciously he must be biassed; it may, as " in my case, be in favour of the soldiers among whom he dwells, or, as in the " instance of more than one of my *confrères*, against the people and the Government " which afford him the hospitality of their lines."

It may be well to state that Mr. Boyle's duties as correspondent lay in European Turkey. The titles of the other books give the necessary information as regards the localities of which they treat.

Sea Terms and Phrases in English. For the Use of Officers of Royal and Mercantile Navies, Engineers, Shipbuilders, &c. By Lieut. E. Pornain, French Navy. 1 vol. Portsmouth: Griffin and Co., 1877. Price 4*s*. Size $8\frac{1}{4}'' \times 5\frac{1}{2}'' \times \frac{3}{8}''$. Pp. 159. Weight under 7 oz.

A useful compendium.

Handbook to South Africa. Including the Cape Colony, Natal, the Diamond Fields, the Trans-Orange Republics, &c. 1 vol. 2nd edition. London: Silver and Co., Cornhill, 1876. Price 10*s*. Size $7'' \times 5'' \times 1\frac{3}{4}''$. Pp. 539. Weight under $1\frac{1}{2}$ lb.

Handbook to the Transvaal. British South Africa, its Natural Features, Industries, Population, and Gold Fields. 1 vol. London: Silver and Co., 1877. Price 2*s*. 6*d*. Size $7'' \times 5'' \times \frac{1}{2}''$. Pp. 125. Weight under 7 oz.

Map of the Transvaal and the Surrounding Territories. By F. Jeppe, F.R.G.S. London: Silver and Co., Cornhill, 1878. Price 7*s*. 6*d*. Size 2 feet square. Scale $\frac{1}{1825000}$, about 30 miles to the inch. Limits 23°—33° W. Long., 21°—40° S. Lat.

Stanford's Compendium of Geography and Travel. Africa. Edited and extended by K. Johnston. 1 vol. London: Stanford, 1878. Price 21*s*. Size $8\frac{1}{4}'' \times 6\frac{1}{4}'' \times 2\frac{1}{4}''$. Pp. 611. Weight under $2\frac{3}{4}$ lbs.

The above-named works will be found useful at the present time.

Received.

Cavalry Tactics. By a Cavalry Officer.
Der Kaiserlich Deutsche Marine. By Bulow.